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STUDIES ON THE VARIATION, DISTRIBUTION, AND EVOLUTION OF THE GENUS PARTULA:

THE SPECIES INHABITING MOOREA

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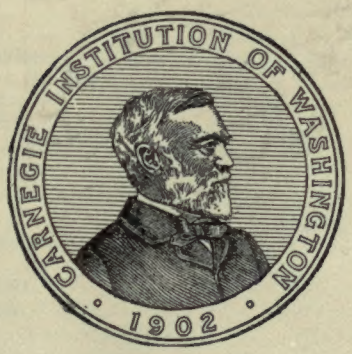

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Published by Carnegie Institution of Washington
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STUDIES ON THE VARIATION, DISTRIBUTION, AND EVOLUTION OF THE GENUS PARTULA

THE SPECIES INHABITING MOOREA

INTRODUCTION

RELATIONS AND SCOPE OF THE PRESENT INVESTIGATION

The present volume is concerned with the nature and natural history of the land-gasteropods belonging to the genus *Partula* which inhabit the island of Moorea. This island is a member of the Society Group and is a near neighbor of Tahiti, whose species have been analyzed and described in the first volume of the series in which the present volume is the third. The entire investigation of the genus *Partula* has been in progress for more than twenty-five years, and during this period the Society Islands have received most attention, because nearly half of the known species of the genus, amounting in all to a little over a hundred, dwell in islands of this group. All of the "high" islands have been explored; and the study of the species of Moorea, now to be recorded, has been greatly facilitated not only by the results obtained in Tahiti, but also by personal knowledge of the forms that inhabit the other islands of the group. In addition, field-work has been carried out elsewhere in Polynesia, notably in the Cook Islands and in Samoa; and an especially helpful study has been completed in the Mariana Islands—Guam and Saipan—situated at the northwestern extreme of the extensive area in which *Partula* exists. A brief visit to the region of the Pelew and Caroline Islands has also been fruitful. The volume on the species of the Mariana Islands was the second to appear, but it is obvious that the present study articulates more directly with the first one dealing with the species of Tahiti.

In view of the extended general accounts given in the earlier volumes, it is not necessary to offer here an elaborate description of the island areas where *Partula* lives. It will suffice to state that the genus ranges from the Austral Islands at the southeast, throughout Polynesia, Melanesia and Micronesia to the northwest. As a rule, only the higher islands of ancient volcanic nature offer suitable ecological conditions for these snails, although some of the Cook Islands composed of uplifted limestone are also inhabited, while still other islands, such as Guam, are composite in nature. Each group bears its own species which do not occur elsewhere, with a notable exception in the special case of *Partula hyalina* Broderip; each island of a group has its own forms, but sometimes the same species will exist in more than a single island of an archipelago. Within the confines of one island, a species may occur in several valleys, differing from place to place, or it may be sharply restricted in its habitat to even a small portion of a valley. Hence the distribution of the genus in its entirety is veritably as ideal as the investigator might desire, inasmuch as the degrees of varietal and specific similarity or divergence can be studied with the most definite determination of the degrees of proximity or isolation of their areas of occurrence.

The fundamental facts of a study like the present one are the characters of the shells of the animals belonging to the species under consideration, and their individual, varietal and specific diversifications from locality to locality. Proceeding

from such data, conclusions are legitimately to be drawn concerning the prior conditions and histories of the several distinguishable colonies and species, in ways that are fully exemplified by the earlier monographs on Tahiti and on the Mariana Islands. The latter comprised this kind of an analysis only, but the former gained greater value from the basis for comparison provided by the extensive work of Garrett throughout the years from 1861 to 1888; with some knowledge of the earlier nature and distribution of the Tahitian species, it was possible to demonstrate changes during relatively recent times, both in the lesser matter of geographical extension and also in the far more important respect of biological differentiation.

The present study goes far beyond the earlier ones, and its results are more numerous and more definite. When the first explorations of Moorea were made in 1907 and 1909, the island was investigated as Tahiti had been, with the expectation that results of the same nature would be obtained. When the biometric study of the Tahitian species had been completed and the Moorean material was taken up for final analysis, it seemed desirable to revisit Moorea in order to fill in certain gaps whose forms would presumably be important as indicated by the qualities of the snails in the bordering localities. Consequently another journey was made in 1919, when additional collections were secured in certain of the former regions as well as in previously unknown territories. It then appeared that noticeable changes had come about, not only in the period from Garrett's time to 1907, but also in the comparatively brief time of the subsequent decade. Hence in 1923 and 1924 the whole island was resurveyed in a much more intensive way, and all of the original localities were reexamined. With an abundance of material from practically every habitable area of Moorea, taken at the beginning and at the end of a period of approximately eleven years, it is now possible to demonstrate many episodes of organic change which had taken place during this interval, as well as others that had occurred after Garrett's time and before 1907. Furthermore the trends of the two series of episodes can be compared and brought into continuous relation. In some instances varietal differentiation has gone forward with truly remarkable rapidity, and this process seems to be continuing to a noticeable extent. It would not be expected that the novel differences would amount in degree to distinctions of *specific* value, but they are the same in nature as such distinctions, and are to be regarded as actual steps in the direction of specific evolution.

Throughout the whole period of the present investigation, an effort has been made to determine the value, if any, of environmental circumstances as causes of organic differentiation. The result is entirely negative. It is true that ecological conditions do indeed limit the areas where the snails can live, but not a single item of proof has come to light that such conditions are *causal* with respect to organic qualities. This statement, in my opinion, gives the only conclusion that is justified by the whole array of facts set forth in the following account.

The collections include 60,316 adult snails and 10,280 others of adolescent growth; the embryonic young dissected from their parents number 45,570. Thus the entire series comprises 116,166 individuals. They have come from over fifty major distinguishable valleys of Moorea, many of which have been explored in

secondary detail. Snails have been procured from most of these areas during both the earlier and the later years of field-work. Ten distinct species exist in Moorea; they differ greatly in their internal diversification, in their areal extension, and in their reconstructed histories of evolution.

It is a difficult problem in itself to analyze and to describe this wealth of material. Following the general plan of the previous volumes, the island of Moorea will first be described for the sake of the pertinent geographical and topographical facts. A comprehensive account of the Moorean species ensues, with the complete census of the adult representatives. Then the several forms are taken up for individual analysis and record, beginning with the simplest and most narrowly localized and progressing to the most complex and wide-spread. The statistical tables are not included in these current descriptions but are relegated to a subsequent part of the volume, thus lightening the task of following the description of the qualitative characters of the several species. A brief discussion is then presented of certain general topics, making use of the whole complex of Moorean species; here the evidences of contemporaneous mutation will be rostered, the relation of individual differences to varietal and specific distinctions will be discussed, the inefficacy of the environment as a cause of organic differentiation will be argued, and the value of the facts for the complicated problem of a prior Pacific land-mass will be duly stressed. A brief résumé completes the body of the whole volume.

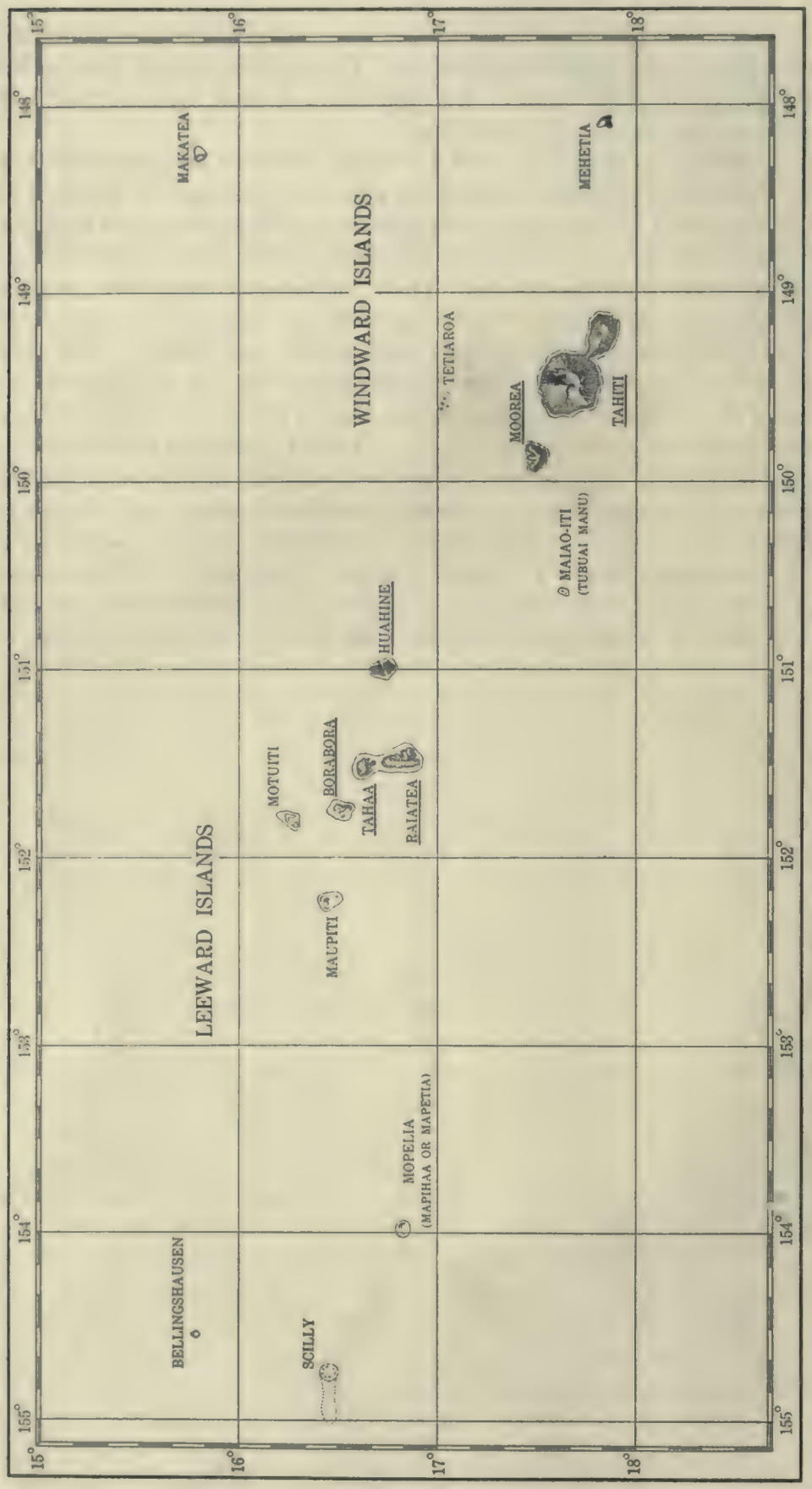

FIG. 1—Chart of Society Islands. Islands with underlined names are inhabited by species of *Partula*.

CHAPTER I

THE ISLAND OF MOOREA

GEOGRAPHY

The Society Islands to which Moorea belongs were so named by Captain Cook in honor of the Royal Society of London under whose auspices he made his noted voyages for the observation of the transit of Venus. Before that, Moorea and its larger neighbor, Tahiti, were called the Georges, or the Georgian Islands, but these names became obsolete before extensive scientific studies were made in the group. During the Nineteenth Century, Moorea was more often called Eimeo, and this appellation still survives in native tradition and song; it also appears in some of the scientific records of the times. Moorea lies to the west-northwest of Tahiti at a distance of about ten geographical miles (text-fig. 1). The coral reefs of the two islands stand well out from their respective shores so that the minimum distance between them is less than nine geographical miles.

Moorea, Tahiti, and a few islands too low and too small to bear Partulæ comprise the Windward subdivision of the whole group. If a line were drawn through the centers of the two components of Tahiti, it would pass almost directly through the center of Moorea; if such a line were further extended, it would run through the midst of the so-called Leeward division comprising Huahine, Raiatea, Tahaa and Borabora, respectively 70, 92, 100 and 116 miles from Moorea. These geographical relations are regular and indicate that the "high" islands of the entire group are the peaks of a massive range whose basis lies beneath the surface of the ocean. While this insular arrangement might be the result of extensive volcanic extrusion along the line of a straight fault, the facts of zoogeography support the alternative conclusion that the present conditions have come about through the subsidence of a connected range, formerly well above the surface of the sea. The fundamental problem at issue will be dealt with in a later chapter after the pertinent facts have been recorded in the descriptions of the several species.

Moorea is almost a regular equilateral triangle in outline (plate 1); its northern border runs nearly due east and west, while its other sides face east-southeast and south-southwest respectively. The extreme northeastern point lies at Lat. 17° 28′ S., Long. 149° 47′ W., and the extreme northwest cape is situated at approximately Lat. 17° 31′ S., Long. 149° 54′ W. The southern point lies at Lat. 17° 35′ S., Long. 149° 48′ W. In general the shores are quite even and straight, with relatively shallow indentations, except on the northern side which is deeply penetrated by two large bays: Faatoai or Opunohu Bay, and Paopao or Cook's Bay. The east-west diameter toward the north is a little less than 10 miles, and the greatest north-south axis is between 6 and 7 miles; hence the whole land area is between 32 and 35 square miles.

Coral reefs occur as fringes along the actual shores of the eastern side, near Faatoai, and sporadically elsewhere. A barrier reef completely encircles the island,

although it is interrupted at various places so as to permit the passage of craft, usually opposite the mouths of the larger fresh-water streams.

TOPOGRAPHY

The topography of Moorea is both interesting and spectacular. No other island with which I am familiar is more picturesque in its bold outline and fantastic sculpture. Its general characteristics are well illustrated in the official chart published by the French Government as shown in plate 1, even though some of the details are not entirely accurate. An outline key to plate 1 is given in plate 2. The photographic illustrations of plates 3 to 12 show many of the major topographic elements of the island as well as the details in certain representative or significant areas.

The outstanding structural feature is a large crescent of mountains (plate 3A) whose points extend to the northwest and northeast with the convexity toward the south. The whole mountain range is part of the wall of an ancient crater, as its petrology and stratification attest. A lofty mountain mass stands apart from the great curving wall in the center of the northern front of Moorea, between Opunohu Bay (plate 3A) and Paopao Bay (plate 4B); this culminates in the peak of Mount Rotui (plate 11). Thus the northern part of the island presents the form of a trident; the outer blunt projections (plate 4A) are penetrated by the ends of the high mountain crescent, while the median one is laterally separated from the outer elements by actual embayments, although its base is continuous with the lower ground of the amphitheater to the south.

The highest peak of the main crescent of mountains is Tohivea (plates 3A and 7A), which stands a little to the east of the exact center of the southern convexity; its altitude is given in the French chart as 4040 feet.

The other peaks of the crescent also stand very high, considering their nearness to the shores. The entire circle falls into four segments by virtue of the existence of three passes (plates 3A, 5A, 9B) whose altitudes range from 1090 feet to 1300 feet. The passes provide lower avenues of communication between the outer areas and the central terrain partly enclosed by the mountains. The segments so distinguished may be designated the northwestern, the west central, the east central and the northeastern.

Beginning at the extreme northwest and following the authority of the French chart, the peaks are Mount Uui (2166 feet), Mount Arapæ (2200 feet), Mount Pafatu (2260 feet), Mount Matotea (2340 feet), Mount Vaiumete (2360 feet), Mount Tatiri, Mount Tiura (2517 feet), and Mount Atiati (2514 feet). Many of these are shown in plates 6A, 7B and 9A. The last named stands as the northern gate-post to the pass between Uufau Valley and western Opunohu Valley, and marks the southern end of the northwest segment of mountains.

The west central segment begins with Mount Mouapu (2547 feet) shown in plates 9B and 12A, and continues by an almost horizontal crenellated wall (plate 9A) for several miles, when it rises abruptly to the extraordinary peak of Mount Mouaroa (2993 feet), pictured in plates 3A; 8A, B, and 9A. Then there is a sharp

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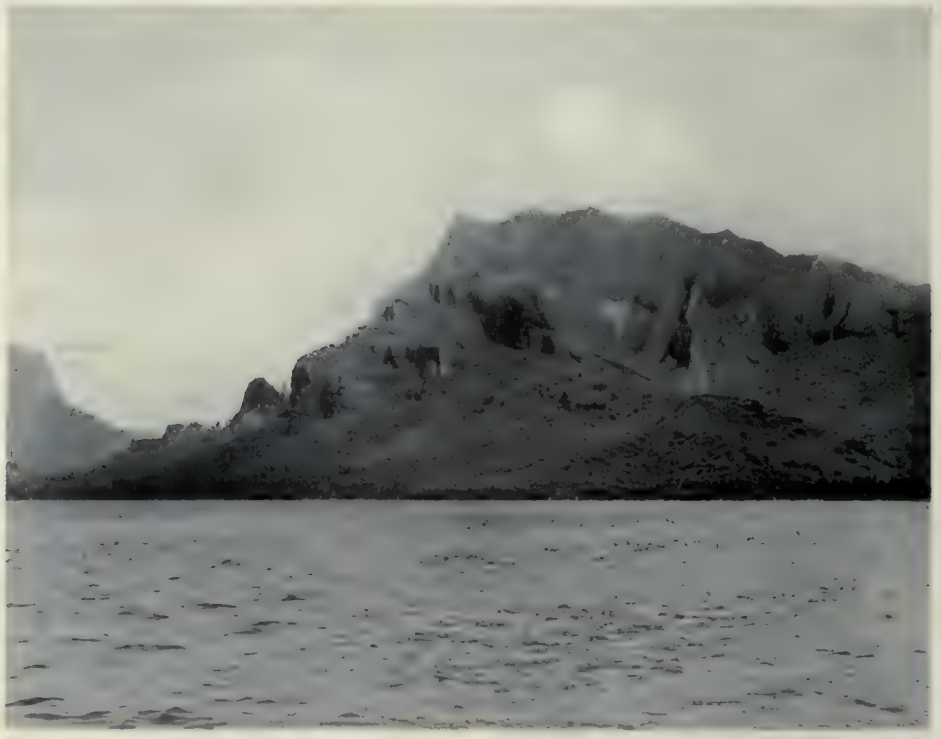
A. Looking south into Opunohu Bay. From left to right (east to west) the peaks of the main crescent of mountains in the distance are Tohivea, Tamarutofa and Mouaroa; part of the southwestern angle of the Mount Rotui sector appears at the left.

B. The extensive valley of Hotutea in the district of Afareaitu, dominated by the highest peak of the island, Mount Tohivea (4,040 feet).

A. Faatoai Valley and the northwestern part of Moorea, as seen from the sea. The high peak is Mount Taatuapæ.



B. The northeastern part of the Rotui sector and the eastern shore of Paopao Bay, from the north. Maahumeru Valley is visible in part at the right, while the inner areas at the left are Punahara and Marure Valleys.

A. Southern part of Vaiare Valley, including the Puutu (left) and Vaipohe (center) divisions. The higher peak is Mount Mouaputa (2,633 feet). The lower transverse ridge is the pass to Paparoa Valley in the interior.

B (Companion to A). Northern or Faamaariri division of Vaiare valley, dominated by the ridge connecting Mount Tearai (2,583 feet) with Mount Teaharoa (2,403 feet).

A. The region of Haapiti, showing dryer coastal ridges between forested valleys. The peaks from right to left are Mouapu (2,547 feet), Atiati (2,514 feet), Tiura (2,517 feet) and Tatiri.

B. Atimaha Valley and its boundaries. The low, forested ridge at the right separates it from Maatea Valley. The mountains at the head are Tohivea and Tamarutofa.

A. Part of the inner circle of valleys from Poua (left) to Tefeo (right). The high mountain is Tohivea (see text-figure 2).

B. The western part of Opunohu Valley; the extreme area (left center) is Vairahi, the central valley is Tupuna, and the forested region at the right is Vaiana. The peaks from left to right are Atiati, Tiura and Taatuapæ.

A. Mount Mouaroa and the upper part of the northern ridge dividing the basin of Opunohu Valley. The forested areas below the peak are those of Faataofe (left) and Fanautaata (right) Valleys.

B. A distant view of Mount Mouaroa, including the area of A (above) together with Mount Tamarutofa and Mount Tohivea. From the crest of the ridge separating Urufara Valley from the Vairahi division of western Opunohu Valley.

A. The crescentic mountain wall from Mouaroa (left) to Mouapu (center) and Atiati (right).

B. Mount Mouapu and the pass (right) across to Uufau Valley. The forested area below Mouapu is Morioahu Valley.

A. The eastern and central parts of Faatoai Valley (*cf.* plate 4A). The area below Mount Taatuapæ is the Upper Mave region. Beyond the ridge descending obliquely to the right lies Taatuapæ Valley, which connects below with the mouth of Vaipapa Valley (extreme right). Teea Valley lies in front of the ridge (see text-figure 3).

B. Uppermost part of central Faatoai Valley where the forests of Upper Mave and Teea Valleys merge near the peak of Mount Taatuapæ.

A. Western aspect of Mount Rotui; Vaihere Valley in the center and Uhene Valley at the left. The boundaries of Vaihiaiia Valley are seen at the right.

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A. The southern part of Uufau Valley and the boundary ridge between Uufau and Haapiti Valleys. The high peak is Mount Mouapu, guarding the pass from Uufau Valley to the interior.

B. Vegetation at the crest of the ridge between the outer valley of Vaiare-Vaipohe and the inner valley of Paparoa; the area is inhabited by *Partulæ*.

drop to 1160 feet, to the ridge separating Vaianai Valley on the coastward side from Maramu Valley in the interior (plates 3A, 8A).

The east central segment includes the highest peaks. Mount Tamarutofa (3053 feet) presents the aspect of a massive panel of rock with a horizontal crest and a wall-like profile when viewed from the east or west (plates 3A, 6B, 8B). Then comes the dominating mountain of Tohivea (4040 feet), commanding both attention and admiration when it appears in view (plates 3A, B; 7A, and 8B, text-fig. 2). Trending somewhat to the northward and then northwestward from Tohivea, the crater wall continues at an approximate level of 2300 feet (plate 7A) to merge with a sharp rise into the mass of Mount Mouaputa (plate 5A), whose strangely pierced summit stands at the height of 2633 feet. This ends the east central segment.

The ridge of the pass between the outer trisected valley of Vaiare and Paparoa Valley in the interior is about 1090 feet in altitude (plate 5A). To the north, the mountain segment in this direction is unusually compact, comprising a massive wall with almost horizontal crest, trending east and west. This wall guards Vaiare Valley on the north and forms the southern boundary of Maharepa Valley. Its western and eastern summits are Mount Tearai (2583 feet) and Mount Teaharoa (2403 feet); the latter is shown in part in plate 5A. The whole northeastern part of the island possesses a relatively simple and regular structure.

Returning to the northwest, we must note the outflung ridge which runs north-northeast from Mount Tiura to the land-mark peak of Mount Taatuapæ (plates 4A; 10A, B; and text-fig. 3). From this summit, ridges fan outward to form the eastern boundary of Faatoai Valley and the enclosing walls of Urufara and Vaitapi Valleys. This part of the island is more complex than the other extremes.

The massif of the Rotui sector is a single unit with a culminating peak at the altitude of 2930 feet. It is very steep on its southern side (plate 11B) and almost equally abrupt on the east and west as well (plate 11A). The profile is naturally more gradual to the north, as the peak is considerably to the south of the geometric center of this sector (plate 4B).

The ridges on the outward sides of the great crescent descend sharply from the prominent peaks to about the level of 1200 or 1300 feet (plates 3B, 6B); they then trend with easier gradient to their coastward terminations (plates 5A, B; 6A, B; 12A). The ridges on the inner side of the crater wall are somewhat similar, but less regular and less pronounced (plates 7A, B; 8A, B; 9A). The eastern, southern and western sides (plate 11A, B) of the Rotui mass are like the inner aspect of the main crater, while the northern part simulates the outer convexity of the great crescent in its features (plate 4B).

The topographical conditions of the island strongly determine the distribution of the vegetation which provides suitable dwelling places for the snails under investigation. As a rule, only the valleys between the radiating ridges are favorable, by virtue of their greater moisture and shade. The forested areas of the valleys are separated by the outer extensions of the radiating ridges, but in the heights they merge into lateral belts of thick vegetation along the cliff-like walls (plates 8A, 9B, 10B). Here also the snails may be found.

AREAS OF HABITATION

The valleys in which collections were made must now be resurveyed, as indicated in plate 2. The review will serve to specify them for complete identification, and will afford an opportunity to record in passing occasional details of significance.

The problem of geographical nomenclature is not always a simple one, because a given valley may bear several names. The general name of a district, a prominent point at the mouth, a dominating peak, a village name, or even a special designation of the principal stream may be used for the whole basin as well as an appellation for the terrain as such. The names given in the chart (plate 2) are in current use, and there is little likelihood that they will be supplanted in the near future.

The outer northwestern array begins with the well-marked valley of Pafatu, sometimes called Tetæuo. Taapurau and Maatepua Valleys do not extend inward to the mountain wall, but are cut into the sector culminating in Mount Tefanio, which stands outward from Mount Matotea. Maraarii Valley, like Pafatu, is a major element reaching inward to the crescent of mountains. The next valley, Varari, is forked so as to be double in the interior; it is wrongly called Faarei in the chart. Moruu Valley is a primary element also, and it is followed by the important valley of Uufau (plate 12A) which leads to the pass intervening between the northwestern segment of the mountain crescent and the west central segment.

The latter is short, and the wide, square area of Haapiti Valley (plate 6A) occupies the greater part of its coastward side. Oio Valley is closely related to Haapiti; another current name for Oio Valley is Vaifare. Then comes the exceedingly important valley of Vaianai, which will be repeatedly discussed in the later special chapters.

The first member of the series of valleys on the outer side of the east central segment, namely, Paahonu Valley, is a lesser element which does not reach all the way inland. Atimaha Valley (plate 6B) is the longest narrow valley of the entire island on account of the greater coastward extension of its limiting ridges. Paia is another small and very short interpolated valley, and yet it is important in connection with the establishment of the limits of certain forms of snails. Then follow the well-marked valleys of Maatea (or Toto), Haumi (or Paaroa) and Hotutea (plate 3B); the last is separated by a long, low ridge from Atiraa or Niuroa Valley. Vaipua is an indentation in the outer ends of the buttresses trending downward from Mount Mouaputa. Here the east central segment ends.

The broad, open valley of Vaiare (plate 5A, B) is so trisected as to be virtually three distinct areas: Puutu, Vaipohe and Faamaariri. Like Vaianai, this area is very important for the interpretation of several species of Partulæ. Tepu is a shallow indentation charted as Puaue; it is followed by the similar area of Maama, in which, however, no collections were made. Temæ Valley is again a major element; beyond this, the ridges to the north are dry and therefore devoid of snails. The great valley of Maharepa, and its smaller neighbor and satellite, Oroau, complete the list of the outer series of valleys; they open out to the north.

The inner series begins at the eastern limit with the shallow area of Farehotu and the major element of Paraoro or Otumai Valley. We then enter the great

amphitheater whose eastern part is called Paopao Valley, although it is by no means a simple or single area from the standpoint of the distribution of the snails. The next individual member here is Paparoa, a large valley which articulates with Vaiare Valley on the coast. Mouaputa and Poua Valleys follow (text-fig. 2), with well-marked individualities. The western boundary of the latter constitutes the main divide between the Paopao division of the amphitheater, and the more extensive remainder, which in its entirety is called Opunohu Valley.

The crater wall is now so sheer and so lofty that the valleys are not distinctly marked as they are on the outer sides of the mountains, as the illustration shows (plate 7A, text-fig. 2). Ririofau, Irua, Fareaito and Tefeo possess independent streams with separated areas of vegetation in their lower parts, but above their forests are continuous. Maramu is the next prominent valley, and it articulates with Vaianai Valley. Its western boundary is a large ridge descending from Mount

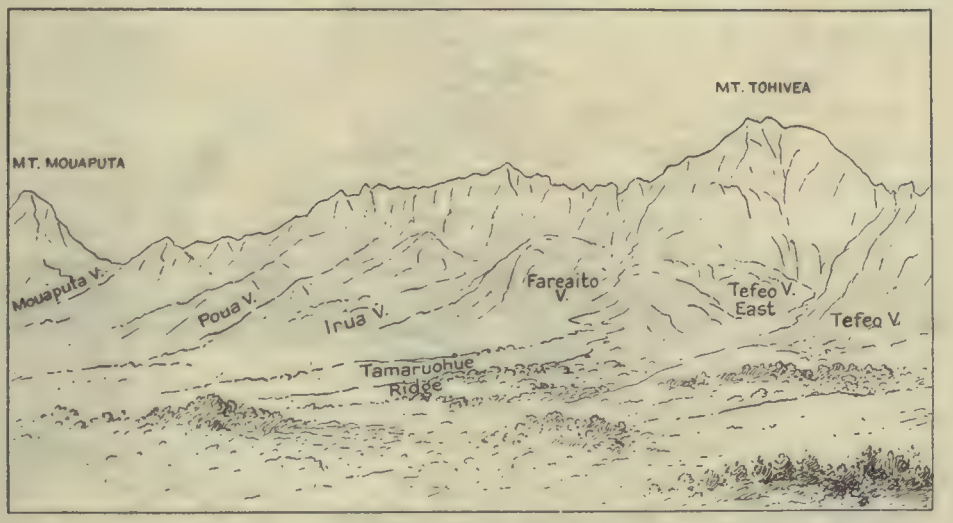


FIG. 2—Inner aspect of mountain wall from Mount Mouaputa to Mount Tohivea, and valleys from Mouaputa to Tefeo; key to plate 7A.

Mouaroa which practically bisects the wide expanse of Opunohu Valley (plate 8A, B). Mouaroa Valley itself lies on the Maramu side of this ridge, but it is really an independent accessory depression. Tiaorooro Valley is a small peripheral indentation in the ridge near its outer end. Westward from the Mouaroa ridge extends a series of relatively shallow valleys comprising Faretaofe, Fanautaata, Roroie and Morioahu (plates 8A, B; 9A, B). Then comes that part of western Opunohu which articulates with Uufau Valley across the divide. This whole region is called "Opunohu West" in the census table; beyond it lies the extreme portion of the Opunohu area specified as Vairahi Valley.

The sequence then becomes somewhat irregular, continuing as it does to two subdivisions of the basin within the northern boundary of western Opunohu, namely, Tupuna and Vaiana Valleys (plate 7B); the latter must not be confused with the far more important area of Vaianai Valley, in the outer circle. We then turn the corner and come out upon the western shores of Opunohu, where Aareo

is an inserted peripheral valley of small size. Urufara Valley, however, is extensive and important, with its western articulation with Vairahi and its northern contact with Faatoai Valley. Vaitapi is a lesser element, also with an abutment on Faatoai Valley.

Faatoai Valley itself opens northward upon the coast (plate 4A), like Maharepa Valley of the northeastern sector; nevertheless it is here treated as a member of the inner series on account of its zoogeographical relations. Its subdivisions bear individual names, as the illustrations show (plate 10A, B; text-fig. 3).

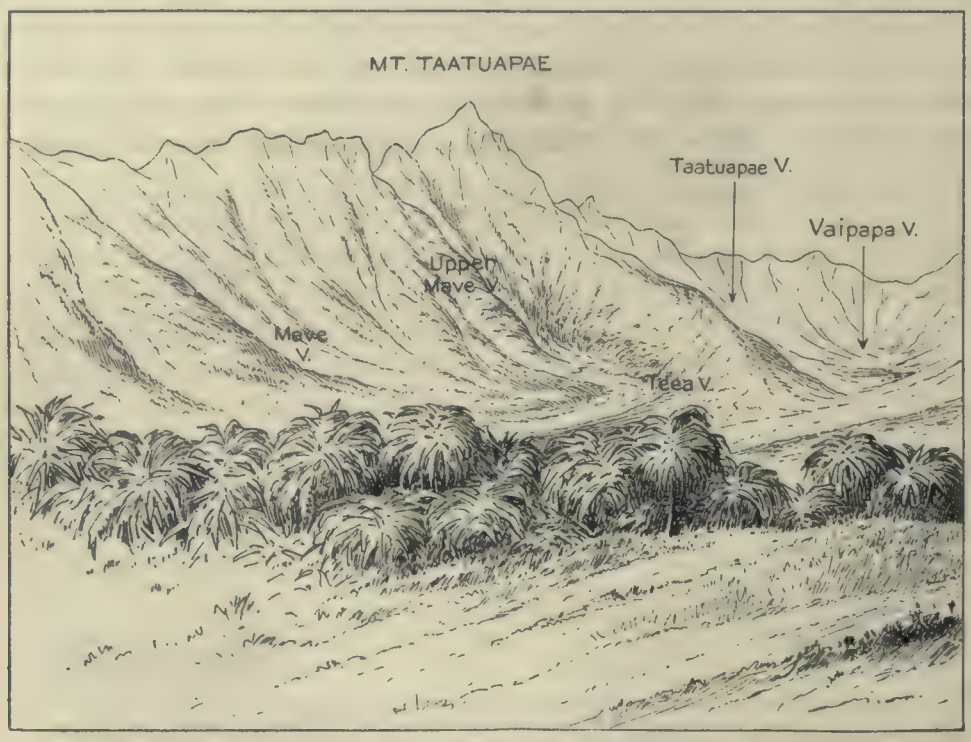


Fig. 3—Eastern and central parts of Faatoai Valley; key to Plate 10A.

Only the two northern valleys of the Rotui sector, namely, Maahumeru (plate 4B) and Faatete or Vaipahu, are standard in topographical respects. Uhene, Vaihere and Vaihiaiia (plate 11A) lie on the western side and are very short radially. The same characteristics recur in Matapoopoo, Tepatu and Pupuhi-Teviroa Valleys on the southern and southwestern sides, as well as in Marure and Punahara Valleys on the east (plate 4B). Matapoopoo faces the Tefeo-Irua segment of the inner circle of valleys, while Tepatu and Pupuhi-Teviroa open out toward Mount Mouaputa.

CHAPTER II

THE COLLECTIONS FROM MOOREA

GENERAL CONSIDERATIONS

The first studies of Moorea were made in 1907 and 1909 during the months of our northern calendar summer. As the Society Islands lie below the equator, this season is the theoretical "winter," but in point of fact the months in question are only a little less hot and wet than the others. In 1907 collections were made in twenty of the major valleys, and in effect the results of their study were similar to those obtained in the Tahitian research; that is, Garrett's descriptive account for his time was confirmed in general, but certain significant differences were demonstrated. In 1909 Moorea was again visited, and thirteen additional localities were explored, as well as six of the former areas from which additional collections were desired. When the volume on the Tahitian species was completed, Moorea was taken up as the next island in geographical sequence, although Raiatea had provided a richer array of known species. As the biometric analysis progressed, it appeared that certain regions had not been given sufficient attention for their full elucidation, and consequently another journey to Moorea was made in 1919. At that time collections were procured from twenty-one valleys, and many of these were duplicates of the 1907 and 1909 series. It was distinctly surprising to find that, in some instances, the later representative collections were not identical with those of former years, while in addition novel forms were found under exceptionally significant circumstances. Hence even more detailed work seemed to be required. When the study of the Mariana Island species had been made and completed, Moorea was much more intensively explored in 1923 and 1924, and an abundance of material was secured for a thorough comparison of the situations in the earlier and later years. While the Tahitian study disclosed the fact that organic differentiation had occurred in some of the species of that island since Garrett's time, it was not anticipated that similar changes could be demonstrated in considerable number and variety for so brief an interval as that which had elapsed from 1907 to 1924.

MATERIAL AND METHODS

The investigation as a whole includes two main parts. The first is the field-work, comprising the collection and preservation of the snails from the individual localities of larger or smaller area. The second involves the complete study of material brought back to the laboratory—dissection of the embryonic young, measurement of the shells, and the time-consuming labor of computing the biometric data.

As a rule, all specimens actually seen were taken by myself and such native assistants as were employed; sometimes, however, the adolescent individuals would be collected only casually, and in very rare cases attention would be paid to some one species of outstanding importance to the relative disregard of others. Obviously the tabulated census proportions of associated species in a given locality

Table 1—*Census of the collections*

Locality	Year	Total			Number of adults														
		adults	adolescents	young	*tæniata* D	*tæniata* S	*suturalis* D	*suturalis* S	*mooreana* D	*mooreana* S	*mirabilis* D	*mirabilis* S	*aurantia* D	*aurantia* S	*dendroica* S	*olympia* S	*tohiveana* S	*exigua* D	*solitaria* D
Outer circle:																			
Pafatu	1907	309	55	172	308	...	...	1	...	...	...	...	...	...	...	...	...	...	...
Pafatu	1919	184	9	92	175	...	...	9	...	...	...	...	...	...	...	...	...	...	...
Taapurau	1923	212	46	79	175	1	...	36	...	...	...	...	...	...	...	...	...	...	...
Taapurau	1924	924	207	537	792	1	...	131	...	...	...	...	...	...	...	...	...	...	...
Maatepua	1924	114	5	66	107	...	...	7	...	...	...	...	...	...	...	...	...	...	...
Maraarii	1907	447	90	363	58	...	(a)	389	...	...	...	...	...	...	...	...	...	...	...
Maraarii	1923	875	116	581	476	...	...	399	...	...	...	...	...	...	...	...	...	...	...
Varari	1909	300	33	246	73	...	...	227	...	...	...	...	...	...	...	...	...	...	...
Varari	1923	827	45	770	476	...	...	351	...	...	...	...	...	...	...	...	...	...	...
Moruu	1907	90	15	37	90	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Moruu	1909	217	86	137	90	...	...	127	...	...	...	...	...	...	...	...	...	...	...
Moruu	1923	652	128	626	242	...	1	409	...	...	...	...	...	...	...	...	...	...	...
Uufau	1907	494	143	310	191	...	38	265	...	...	...	...	...	...	...	...	...	...	...
Uufau	1923	662	136	626	129	...	156	377	...	...	...	...	...	...	...	...	...	...	...
Haapiti	1907	270	44	151	29	...	223	18	...	...	...	...	...	...	...	...	...	...	...
Haapiti	1923	465	95	452	161	...	266	...	...	38	...	...	...	...	...	...	...	...	...
Oio	1919	1,267	183	0	541	1	604	8	(b)	112	1	...	...	...	...	...	...	...	...
Oio	1923	343	20	303	58	...	158	...	...	127	...	...	...	...	...	...	...	...	...
Vaianai	1907	901	151	430	107	...	271	...	...	523	...	...	...	...	...	...	...	...	...
Vaianai	1919	774	43	493	346	...	37	...	...	391	...	...	...	...	...	...	...	...	...
Vaianai	1923	1,410	143	829	67	...	98	...	...	1,171	74	...	...	...	...	...	...	...	...
Paahonu	1919	97	22	105	57	...	39	...	...	1	...	...	...	...	...	...	...	...	...
Atimaha	1907	125	35	77	8	...	103	...	...	14	...	...	...	...	...	...	...	...	...
Atimaha	1919	1,029	89	503	449	...	5	...	...	575	...	...	...	...	...	...	...	...	...
Atimaha	1923	1,016	98	715	166	...	174	...	...	676	...	...	...	...	...	...	...	...	...
Paia	1919	15	3	0	1	...	14	...	...	...	...	...	...	...	...	...	...	...	...
Maatea	1907	255	52	67	17	...	238	...	...	...	...	...	...	...	...	...	...	...	...
Maatea	1924	439	120	231	98	...	341	...	...	...	...	...	...	...	...	...	...	...	...
Haumi	1907	428	167	121	7	...	421	...	...	...	...	...	...	...	...	...	...	...	...
Haumi	1919	415	56	472	87	...	328	...	...	...	...	...	...	...	...	...	...	...	...
Haumi	1924	1,349	228	592	119	...	1,230	...	...	...	...	...	...	...	...	...	...	...	...
Hotutea	1907	371	108	185	88	...	283	...	...	...	...	...	...	...	...	...	...	...	...
Hotutea	1924	865	197	516	224	...	641	...	...	...	...	...	...	...	...	...	...	...	...
Atiraa	1907	507	66	192	379	...	128	...	...	...	...	...	...	...	...	...	...	...	...
Atiraa	1924	438	53	201	227	...	211	...	...	...	...	...	...	...	...	...	...	...	...
Vaipua	1924	124	14	90	124	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Vaiare—Puutu	1907	424	61	258	343	...	62	18	...	...	...	...	...	...	...	...	...	1	...
Vaiare—Puutu	1919	389	154	217	236	...	104	47	...	...	...	...	...	...	...	...	...	2	...
Vaiare—Vaipohe	1919	236	43	199	126	...	5	1	...	...	...	...	104	...	...	...	...	...	...
Vaiare—Vaipohe	1924	487	103	457	296	...	164	3	...	...	...	...	24	...	...	...	...	...	...
Vaiare—Faamaariri	1919	537	173	398	297	...	154	86	...	...	...	...	...	...	...	...	...	...	...
Vaiare—Faamaariri (A)	1923	849	64	912	575	...	79	69	...	...	...	...	121	...	...	...	...	5	...
Vaiare—Faamaariri (B)	1923	804	54	799	525	...	132	143	...	...	...	...	...	...	...	...	...	4	...
Vaiare—Faamaariri	1924	916	221	809	607	...	172	28	...	...	...	...	82	...	...	...	...	27	...
Tepu	1907	70	2	36	70	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Tepu	1919	458	[illegible]	201	421	...	...	22	...	...	...	...	...	...	...	...	...	15	...
Temæ	1923	499	[illegible]	342	499	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Maharepa	1907	585	54	183	583	...	...	...	...	...	...	...	...	...	...	...	...	2	...
Maharepa	1923	1,009	90	847	889	...	...	79	...	...	...	...	...	...	...	...	...	41	...
Oroau	1923	156	3	53	156	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Inner circle:																			
Farehotu	1924	459	14	127	459	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Paraoro middle	1909	431	113	213	259	...	...	...	...	...	...	...	165	...	...	...	...	7	...
Paraoro middle	1923	603	105	340	358	...	...	...	...	...	...	...	215	...	...	...	...	30	...
Paraoro south	1923	350	79	333	142	...	...	...	...	...	...	...	180	1	...	...	...	27	...
Paopao north	1923	251	26	198	251	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Paparoa (low)	1907	220	54	150	220	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Paparoa (high)	1909	357	112	298	85	...	[illegible]	...	...	...	...	...	269	1	...	...	...	...	...
Paparoa (low)	1919	663	14	830	663	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Paparoa (high)	1919	149	39	135	44	...	...	...	...	...	...	...	105	...	...	...	...	...	...
Paparoa (high)	1923	482	135	558	125	...	...	...	...	...	...	...	357	...	...	...	...	...	...
Mouaputa (A)	1919	279	60	377	139	...	136	...	...	...	...	...	...	...	...	4	...	...	...
Mouaputa (B)	1919	621	143	654	356	...	218	...	...	...	...	...	...	...	...	47	...	...	...
Mouaputa	1923	272	101	393	82	...	190	...	...	...	...	...	...	...	...	...	...	...	...
Poua	1919	85	73	105	23	...	62	...	...	...	...	...	...	...	...	...	...	...	...
Poua	1923	104	30	141	51	...	53	...	...	...	...	...	...	...	...	...	...	...	...
Ririofau	1924	381	81	477	299	...	59	...	...	...	23	...	...	...	...	...	...	...	...
Irua	1907	90	15	58	90	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Irua	1919	581	74	309	231	...	6	...	...	...	344	...	...	...	...	...	...	...	...
Irua	1923	456	130	569	171	...	49	...	...	...	236	...	...	...	...	...	...	...	...

(a) Dextral embryo present. (b) Two dextral adolescents.

TABLE 1—*Census of the collections*—Continued

Locality	Year	Per cent of adult population																			
		taniata		*suturalis*		*moorana*		*mirabilis*		*aurantia*		*dendroica*	*olympia*	*tohiveana*	*exigua*	*solitaria*					
		D	S	D	S	D	S	D	S	D	S	S	S	S	S	D					
Outer circle:																					
Pafatu	1907	99.68	...	...	0.32	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Pafatu	1919	95.11	...	...	4.89	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Taapurau	1923	82.55	0.47	...	16.98	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Taapurau	1924	85.71	0.11	...	14.18	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Maatepua	1924	93.86	...	...	6.14	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Maraarii	1907	12.97	...	...	87.02	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Maraarii	1923	54.40	...	...	45.60	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Varari	1909	24.33	...	...	75.67	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Varari	1923	57.56	...	...	42.44	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Moruu	1907	100.	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Moruu	1909	41.47	...	...	58.51	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Moruu	1923	37.11	...	0.15	62.73	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Uufau	1907	38.66	...	7.69	53.64	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Uufau	1923	19.49	...	23.56	56.95	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Haapiti	1907	10.74	...	82.58	6.67	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Haapiti	1923	34.62	...	57.20	...	...	8.17	...	...	...	...	.....	.....	.....	.....	.....					
Oio	1919	42.70	0.08	47.67	0.63	...	8.84	0.08	...	...	...	.....	.....	.....	.....	.....					
Oio	1923	16.91	...	46.06	...	...	37.03	...	...	...	...	.....	.....	.....	.....	.....					
Vaianai	1907	11.87	...	30.08	...	...	58.05	...	...	...	...	.....	.....	.....	.....	.....					
Vaianai	1919	44.70	...	4.78	...	...	50.52	...	...	...	...	.....	.....	.....	.....	.....					
Vaianai	1923	4.75	...	6.95	...	...	83.05	5.25	...	...	...	.....	.....	.....	.....	.....					
Paahonu	1919	58.76	...	40.21	...	...	1.03	...	...	...	...	.....	.....	.....	.....	.....					
Atimaha	1907	6.40	...	82.40	...	...	11.20	...	...	...	...	.....	.....	.....	.....	.....					
Atimaha	1919	43.63	...	0.48	...	...	55.88	...	...	...	...	.....	.....	.....	.....	.....					
Atimaha	1923	16.34	...	17.13	...	...	66.53	...	...	...	...	.....	.....	.....	.....	.....					
Paia	1919	6.67	...	93.33	...	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Maatea	1907	6.67	...	93.33	...	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Maatea	1924	22.32	...	77.68	...	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Haumi	1907	1.63	...	98.37	...	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Haumi	1919	20.96	...	79.04	...	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Haumi	1924	8.82	...	91.18	...	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Hotutea	1907	23.72	...	76.28	...	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Hotutea	1924	25.89	...	74.10	...	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Atiraa	1907	74.75	...	25.24	...	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Atiraa	1924	51.83	...	48.17	...	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Vaipua	1924	100.	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Vaiare—Puutu	1907	80.89	...	14.62	4.24	...	...	...	...	...	...	.....	.....	.....	0.23	.....					
Vaiare—Puutu	1919	60.67	...	26.73	12.08	...	...	...	...	...	...	.....	.....	.....	0.51	.....					
Vaiare—Vaipohe	1919	53.39	...	2.12	0.42	...	...	...	...	44.07	...	.....	.....	.....	.....	.....					
Vaiare—Vaipohe	1924	60.78	...	33.67	0.61	...	...	...	...	4.93	...	.....	.....	.....	.....	.....					
Vaiare—Faamaariri	1919	55.31	...	28.68	16.01	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Vaiare—Faamaariri (A)	1923	67.73	...	9.30	8.13	...	...	...	...	14.24	...	.....	.....	.....	0.59	.....					
Vaiare—Faamaariri (B)	1923	65.29	...	16.42	17.78	...	...	...	...	...	...	.....	.....	.....	0.50	.....					
Vaiare—Faamaariri	1924	66.26	...	18.78	3.06	...	...	...	...	8.95	...	.....	.....	.....	2.95	.....					
Tepu	1907	100.	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Tepu	1919	91.92	...	91.92	4.80	...	...	...	...	...	...	.....	.....	.....	3.28	.....					
Temæ	1923	100.	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Maharepa	1907	99.65	...	...	...	...	...	...	...	...	...	.....	.....	.....	0.34	.....					
Maharepa	1923	88.11	...	...	7.83	...	...	...	...	...	...	.....	.....	.....	4.06	.....					
Oroau	1923	100.	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Inner circle:																					
Farehotu	1924	100.	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Paraoro middle	1909	60.09	...	...	...	...	...	...	...	38.28	...	.....	.....	.....	1.62	.....					
Paraoro middle	1923	59.37	...	...	...	...	...	...	...	35.65	...	.....	.....	.....	4.97	.....					
Paraoro south	1923	40.57	...	...	...	...	...	...	...	51.43	0.28	.....	.....	.....	7.72	.....					
Paopao north	1923	100.	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Paparoa (low)	1907	100.	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Paparoa (high)	1909	23.81	...	0.56	...	...	...	...	...	75.35	0.28	.....	.....	.....	.....	.....					
Paparoa (low)	1919	100.	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Paparoa (high)	1919	29.53	...	...	...	...	...	...	...	70.47	...	.....	.....	.....	.....	.....					
Paparoa (high)	1923	25.93	...	...	...	...	...	...	...	74.07	...	.....	.....	.....	.....	.....					
Mouaputa (A)	1919	49.82	...	48.74	...	...	...	...	...	...	...	.....	1.43	.....	.....	.....					
Mouaputa (B)	1919	57.33	...	35.10	...	...	...	...	...	...	...	.....	7.56	.....	.....	.....					
Mouaputa	1923	30.15	...	69.85	...	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Poua	1919	27.06	...	72.94	...	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Poua	1923	49.04	...	50.96	...	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Ririofau	1924	78.48	...	15.48	...	...	...	6.04	...	...	...	.....	.....	.....	.....	.....					
Irua	1907	100.	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....					
Irua	1919	39.76	...	1.03	...	...	...	59.21	...	...	...	.....	.....	.....	.....	.....					
Irua	1923	37.50	...	10.74	...	...	...	51.75	...	...	...	.....	.....	.....	.....	.....					

Table 1—*Census of the collections*—Continued

Locality	Year	Total: adults	Total: adolescents	Total: young	*tæniata* D	*tæniata* S	*suturalis* D	*suturalis* S	*mooreana* D	*mooreana* S	*mirabilis* D	*mirabilis* S	*aurantia* D	*aurantia* S	*dendroica* S	*olympia* S	*tohiveana* S	*exigua* D	*solitaria* D
Inner circle (*cont.*):																			
Fareaito	1923	1,214	339	1,610	628	...	177	...	...	...	131	...	...	...	...	...	278	...	...
Fareaito	1924	1,332	194	1,086	598	...	36	...	...	...	296	...	...	...	...	...	402	...	...
Tefeo east	1923	1,129	262	1,127	233	...	53	...	...	...	843	...	...	...	...	...	...	...	...
Tefeo	1923	769	174	814	153	...	42	...	(c)	93	481	...	...	...	...	...	...	...	...
Maramu	1909	425	24	431	49	...	(d)	...	3	48	323	2	...	...	...	...	...	...	...
Maramu	1919	355	88	292	126	...	93	...	...	98	38	...	...	...	...	...	...	...	...
Maramu	1923	616	121	512	42	...	28	...	1	494	51	...	...	...	...	...	...	...	...
Maramu	1924	1,696	280	1,361	323	...	67	...	1	1,091	214	(e)	...	...	...	...	...	...	...
Mouaroa	1924	322	119	177	202	...	88	...	...	...	32	...	...	...	...	...	...	...	...
Tiaorooro	1923	43	9	52	43	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Faataofe	1923	687	206	932	163	...	167	...	...	212	142	3	...	...	...	...	...	...	...
Faataofe	1924	894	121	804	46	...	217	...	4	224	396	7	...	...	...	...	...	...	...
Fanautaata	1923	305	70	462	125	...	174	...	...	6	...	...	...	...	...	...	...	...	...
Roroie	1923	583	55	885	207	...	320	...	...	56	...	...	...	...	...	...	...	...	...
Morioahu east	1923	307	117	482	116	...	79	112	...	...	...	...	...	...	...	...	...	...	...
Morioahu	1923	780	238	1,057	319	...	106	355	...	...	...	...	...	...	...	...	...	...	...
Opunohu west	1907	248	102	207	99	...	4	145	...	...	...	...	...	...	...	...	...	...	...
Opunohu west	1909	341	75	289	247	...	...	94	...	...	...	...	...	...	...	...	...	...	...
Opunohu west, below pass	1919	214	94	120	130	...	7	77	...	...	...	...	...	...	...	...	...	...	...
Opunohu west, below pass	1923	404	27	463	213	...	3	188	...	...	...	...	...	...	...	...	...	...	...
Opunohu west, below Atiati (A)	1923	353	108	316	149	...	(f)	204	...	...	...	...	...	...	...	...	...	...	...
Opunohu west, below Atiati (B)	1923	289	55	357	121	...	1	167	...	...	...	...	...	...	...	...	...	...	...
Opunohu west, Vairahi	1924	843	204	605	682	...	...	161	...	...	...	...	...	...	...	...	...	...	...
Tupuna	1923	462	117	486	289	...	(g)	173	...	...	...	...	...	...	...	...	...	...	...
Vaiana	1923	272	77	291	195	...	1	76	...	...	...	...	...	...	...	...	...	...	...
Aareo	1909	55	9	21	54	...	...	1	...	...	...	...	...	...	...	...	...	...	...
Aareo	1919	80	12	48	78	...	...	2	...	...	...	...	...	...	...	...	...	...	...
Aareo	1923	186	55	70	177	...	...	9	...	...	...	...	...	...	...	...	...	...	...
Urufara	1907	404	44	247	394	...	...	10	...	...	...	...	...	...	...	...	...	...	...
Urufara	1909	316	40	203	296	...	...	20	...	...	...	...	...	...	...	...	...	...	...
Urufara south (A)	1923	133	41	78	121	...	...	12	...	...	...	...	...	...	...	...	...	...	...
Urufara south (B)	1923	919	44	494	918	...	...	1	...	...	...	...	...	...	...	...	...	...	...
Urufara south (C)	1923	267	86	193	219	...	...	48	...	...	...	...	...	...	...	...	...	...	...
Urufara north	1923	162	16	180	162	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Urufara north central	1924	164	64	141	104	...	...	60	...	...	...	...	...	...	...	...	...	...	...
Poararua	1923	454	10	178	454	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Vaitapi	1923	120	9	105	120	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Vaitapi	1924	60	18	55	60	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Faatoai	1907	207	6	99	269	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Faatoai	1909	333	24	225	317	...	...	16	...	...	...	...	...	...	...	...	...	...	...
Faatoai	1919	945	18	267	886	...	...	59	...	...	...	...	...	...	...	...	...	...	...
Faatoai, Mave	1923, 1924	362	53	142	338	...	...	24	...	...	...	...	...	...	...	...	...	...	...
Faatoai, Mave upper	1924	157	16	84	143	...	...	14	...	...	...	...	...	...	...	...	...	...	...
Faatoai, Teea	1923	67	14	53	67	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Faatoai, Taatuapæ	1923	518	100	423	500	...	...	17	...	...	...	...	...	...	...	...	...	...	1
Faatoai, Vaipapa	1924	459	72	245	444	...	...	15	...	...	...	...	...	...	...	...	...	...	...
Faatoai, Terahimaue	1923	398	30	264	391	...	...	7	...	...	...	...	...	...	...	...	...	...	...
Faatoai, Mataitau	1923	271	59	93	266	...	...	5	...	...	...	...	...	...	...	...	...	...	...
Rotui Sector:																			
Uhene	1923	425	74	273	425	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Vaihere	1909	70	8	52	70	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Vaihere	1923	128	24	46	128	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Vaihiaiia north	1924	167	38	104	152	...	...	...	...	...	...	...	...	...	15	...	...	...	...
Vaihiaiia middle	1909	253	75	143	240	...	...	...	...	...	...	...	...	...	13	...	...	...	...
Vaihiaiia south	1923	307	84	198	289	1	...	...	...	...	...	...	...	...	17	...	...	...	...
Matapoopoo	1909	204	60	115	135	...	...	...	...	...	69	...	...	...	...	...	...	...	...
Matapoopoo	1919	875	17	262	647	...	...	...	...	...	215	...	...	...	13	...	...	...	...
Matapoopoo west	1923	695	68	677	109	...	...	...	...	...	580	...	...	...	6	...	...	...	...
Matapoopoo east	1923	135	22	38	3	...	...	...	...	...	131	...	...	...	1	...	...	...	...
Tepatu	1919	65	6	52	65	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Tepatu	1923	253	34	150	224	...	...	...	...	...	...	...	...	...	29	...	...	...	...
Pupuhi—Teviroa	1919	92	4	72	92	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Pupuhi—Teviroa	1923	309	127	193	275	...	...	...	...	...	...	...	...	...	34	...	...	...	...
Marure	1909	343	13	198	343	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Punahara	1923	512	16	503	512	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Maahumeru	1919	38	1	25	38	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Summary:																			
Outer circle		26,629	4,135	17,078	12,365	3	6,880	3,250	...	3,628	75	...	331	...	...	...	...	97	...
Inner circle		28,816	5,474	25,391	16,324	...	2,438	2,072	9	2,322	3,550	12	1,291	2	...	51	680	64	1
Rotui sector		4,871	662	3,101	3,747	1	...	...	...	...	995	...	...	...	128	...	...	...	...
Whole Island		60,316	10,280	45,570	32,436	4	9,318	5,322	9	5,950	4,620	12	1,622	2	128	51	680	161	1

(c) Two dextral embryos. (d) One dextral adolescent. (e) One sinistral adolescent. (f) One dextral adolescent. (g) Four dextral adolescents.

TABLE 1—*Census of the collections*—Concluded

Locality	Year	Per cent of adult population																					
		taeniata		*suluralis*		*moreana*		*mirabilis*		*aurantia*		*dendroica*	*olympia*	*tohiveana*	*exigua*	*solitaria*							
		D	S	D	S	D	S	D	S	D	S	S	S	S	D	D							
Inner circle (*cont.*):																							
Fareaito	1923	51.73	...	14.58	...	...	...	10.79	...	...	...	.....	.....	22.90	.....	.....							
Fareaito	1924	44.89	...	2.70	...	...	...	22.22	...	...	...	.....	.....	30.18	.....	.....							
Tefeo east	1923	20.64	...	4.69	...	...	...	74.67	...	...	...	.....	.....	.....	.....	.....							
Tefeo	1923	19.90	...	5.46	...	...	12.09	62.55	...	...	...	.....	.....	.....	.....	.....							
Maramu	1909	11.53	...	...	...	0.71	11.29	76.00	0.47	...	...	.....	.....	.....	.....	.....							
Maramu	1919	35.49	...	26.20	...	...	27.61	10.70	...	...	...	.....	.....	.....	.....	.....							
Maramu	1923	6.82	...	4.54	...	0.16	80.19	8.28	...	...	...	.....	.....	.....	.....	.....							
Maramu	1924	19.04	...	3.95	...	0.06	64.33	12.62	...	...	...	.....	.....	.....	.....	.....							
Mouaroa	1924	62.73	...	27.33	...	...	...	9.94	...	...	...	.....	.....	.....	.....	.....							
Tiaorooro	1923	100.	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Faataofe	1923	23.72	...	24.81	...	...	30.86	20.67	0.43	...	...	.....	.....	.....	.....	.....							
Faataofe	1924	5.14	...	24.27	...	0.56	25.06	44.18	0.78	...	...	.....	.....	.....	.....	.....							
Fanautaata	1923	40.98	...	57.05	...	...	1.97	...	...	...	...	.....	.....	.....	.....	.....							
Roroie	1923	35.51	...	54.89	...	...	9.60	...	...	...	...	.....	.....	.....	.....	.....							
Morioahu east	1923	37.78	...	25.73	36.48	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Morioahu	1923	40.90	...	13.59	45.51	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Opunohu west	1907	39.92	...	1.61	58.47	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Opunohu west	1909	72.43	...	...	27.57	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Opunohu west, below pass	1919	60.75	...	3.27	35.98	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Opunohu west, below pass	1923	52.72	...	0.74	46.53	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Opunohu west, below Atiati (A)	1923	42.21	...	...	57.79	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Opunohu west, below Atiati (B)	1923	41.87	...	0.35	57.78	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Opunohu west, Vairahi	1924	80.90	...	...	19.10	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Tupuna	1923	62.55	...	...	37.44	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Vaiana	1923	71.69	...	0.37	27.94	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Aareo	1909	98.18	...	...	1.82	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Aareo	1919	97.50	...	...	2.50	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Aareo	1923	95.16	...	...	4.84	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Urufara	1907	97.52	...	...	2.47	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Urufara	1909	93.67	...	...	6.33	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Urufara south (A)	1923	90.98	...	...	9.02	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Urufara south (B)	1923	99.89	...	...	0.11	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Urufara south(C)	1923	82.02	...	...	17.98	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Urufara north	1923	100.	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Urufara north central	1924	63.41	...	...	36.58	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Poararua	1923	100.	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Vaitapi	1923	100.	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Vaitapi	1924	100.	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Faatoai	1907	100.	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Faatoai	1909	95.19	...	...	4.80	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Faatoai	1919	93.76	...	...	6.24	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Faatoai, Mave	1923/1924	93.37	...	...	6.63	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Faatoai, Mave upper	1924	91.08	...	...	8.92	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Faatoai, Teea	1923	100.	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Faatoai, Taatuapæ	1923	96.52	...	...	3.28	...	...	...	...	...	...	.....	.....	.....	.....	0.19							
Faatoai, Vaipapa	1924	96.73	...	...	3.27	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Faatoai, Terahimaue	1923	98.24	...	...	1.76	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Faatoai, Mataitau	1923	98.15	...	...	1.84	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Rotui sector:																							
Uhene	1923	100.	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Vaihere	1909	100.	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Vaihere	1923	100.	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Vaihiaiia north	1924	91.02	...	...	...	...	...	...	...	...	...	8.98	.....	.....	.....	.....							
Vaihiaiia middle	1909	94.86	...	...	...	...	...	...	...	...	...	5.14	.....	.....	.....	.....							
Vaihiaiia south	1923	94.14	0.32	...	...	...	...	...	...	...	...	5.54	.....	.....	.....	.....							
Matapoopoo	1909	66.18	...	...	...	...	...	33.82	...	...	...	.....	.....	.....	.....	.....							
Matapoopoo	1919	73.94	...	...	...	...	...	24.87	...	...	...	1.48	.....	.....	.....	.....							
Matapoopoo west	1923	15.68	...	...	...	...	...	83.45	...	...	...	0.86	.....	.....	.....	.....							
Matapoopoo east	1923	2.22	...	...	...	...	...	97.04	...	...	...	0.74	.....	.....	.....	.....							
Tepatu	1919	100.	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Tepatu	1923	88.54	...	...	...	...	...	...	...	...	...	11.46	.....	.....	.....	.....							
Pupuhi—Teviroa	1919	100.	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Pupuhi—Teviroa	1923	89.	...	...	...	...	...	...	...	...	...	11.00	.....	.....	.....	.....							
Marure	1909	100.	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Punahara	1923	100.	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Maahumeru	1919	100.	...	...	...	...	...	...	...	...	...	.....	.....	.....	.....	.....							
Summary:																							
Outer circle		46.43	0.01	25.84	12.20	...	13.62	0.28	...	1.24	...	.....	.....	.....	0.36	.....							
Inner circle		56.65	...	8.46	7.19	0.03	8.06	12.32	0.04	4.48	0.01	.....	0.18	2.36	0.22	0.003							
Rotui sector		76.92	0.02	...	...	...	...	20.43	...	...	...	2.63	.....	.....	.....	.....							
		53.77	0.01	15.45	8.82	0.01	9.86	7.66	0.02	2.69	0.003	0.21	0.08	1.13	0.27	0.002							
Whole Island		53.78		24.27		9.87		7.68		2.69													

are qualified in these few instances. The author is personally responsible for the identification of the localities where snails were procured and for the major part of the actual collecting itself; in no case has reliance been placed on native assistants alone without the writer's personal knowledge of the terrain and of the kinds of animals dwelling in a particular locality. In a very few instances where an earlier exploring trip had discovered material of special value, trained and dependable native assistants were sent for the purpose of amplifying the collections; this was never done without a personal check on the actual journey made by these assistants. The data relating to the material are authentic throughout the whole ensuing record.

The snails were drowned and expanded by immersion in fresh water for a number of hours, and were then preserved in formaline. The exigencies of field-work make it impossible to study the material in detail on the ground. Only when the collections are assembled in the laboratory can their full values be realized, with the aid of the charts, photographs, and the accumulated notes of the field-books. The second part of the investigation then proceeds with the assortment of the snails into their proper species and varieties, locality by locality. The bodies are extracted, the embryonic contents recorded, and the shells measured. Each individual shell is marked for identification. The data for every adult snail entered in the basic tables range from a minimum of ten to fifteen or more.

The author is himself responsible for the measurement of the shells and for all of the biometric calculations; hence the personal coefficient is as uniform as possible. The direct measures are four, as in the Tahitian and Mariana Island studies, namely (1) length and (2) width of the whole shell, (3) length and (4) width of the aperture, outside dimensions. The relative measures are (5) the proportions of the shell, (6) proportions of the aperture, and (7) the proportions of the length of the aperture to that of the entire shell. The character of the tooth on the parietal wall, if it is present, is recorded by an index number from 1, denoting absence, to 5, denoting very large growth. The additional entries relate to the embryonic material, namely, the quality of the capsular wall, the number of "eggs" or very young embryos, the number of the "young" or more advanced embryos, together with the modes of coil of the latter and their color-characters, when these can be determined.

The qualitative characters of the foregoing list are categorical for the most part, and admit an error of observation only where an estimate of the depth of color or size of a parietal tooth are involved; even here, however, the judgment has been made by one and the same individual and it has been constantly guided by reference to what had been accomplished previously. The direct measurements of the shells were made with the utmost care; and when work of this kind was resumed after an interval, some time was devoted to practise before any records were entered as final.

The descriptive constants are the usual ones of biometry, namely, the average, the standard deviation, and the probable errors of both. When two series are compared on the basis of similar numerical constants, the difference is regarded as significant only where it is at least three times its probable error.

While the labor involved in the biometric analysis of the material is considerable, yet it produces results which are otherwise unattainable. The species come to be defined more accurately than would be possible without the descriptive constants, and differences between any two of them or among their components are disclosed which would escape inspection otherwise. Furthermore, as in the case of the studies of the species of Tahiti and the Mariana Islands, a base is given for such comparisons as may be made after a long interval of time, when exact data on the time-rate of evolution may be secured.

The material from Moorea described in the present volume comprises 60,316 adult snails, 10,280 adolescent individuals, and 45,570 embryonic young which were sufficiently advanced in development to display definite characters. The total number is therefore 116,166 snails of all sizes. It was collected in fifty-six circumscribed geographical regions in the way of the forested areas of the several valleys of Moorea, which, however, are not all equivalent in size, as the description of the previous chapter has shown. A subdivision of a large valley like Vaiare or Faatoai may be quite as isolated and as extensive as a lesser independent valley like Aareo or Vaipua, which must be considered a primary topographic element. As the collections taken from one and the same valley in different years must be treated separately, the total number of the associations or "series" amounts to 134. The several species are very diversely represented in these series; only one occurs in all of them, while at the opposite extreme stand two species which appear only in two series, and one species that occurs only in a single collection. The number of "species-series" requiring independent treatment amounts to 301. With scarcely any exception, each of these comprises subordinate varieties or components which differ in coloration or in spirality. Hence the biometric constants must be determined for an entire array of classified subordinate groups number many hundreds.

CENSUS OF THE SPECIES

The general census (table 1) gives the absolute numbers of the adults, adolescents and young of all of the Moorean species, and also the absolute and proportionate numbers of the adults belonging to the several species as represented in the collections. A summary of the full census is given in table 2.

Ten species of *Partula* are recorded. Three of these have long standing in the literature, namely *Partula tæniata* Mörch (1850), *Partula suturalis* Pfeiffer (1855) and *Partula mooreana* Hartman (1880). The first is so richly diversified that many of its primary varieties have been described as separate species by authors who usually had very few representative specimens at their disposal. The second has also been the subject of varied opinion, but it is much less difficult to analyze than the first; Garrett (1884) called it *Partula lineata* Lesson, but changed his opinion later. The third has an unclouded history. Pilsbry's *Manual of Conchology* lists *Partula erhelii* Morelet (1853); Garrett (1884) does not recognize it, and I have not been able to distinguish it as a separate species. If Morelet's type did indeed come from Moorea, it is probably a variant of some subspecies of *Partula tæniata*. Garrett (1884) insisted that *Partula elongata* Pease (1866) is a

valid Moorean species. I concur in Pilsbry's opinion that it is really a primary variety of *Partula tæniata* Mörch. In summary, therefore, the older species of Moorea with long and accepted standing number three, with *Partula erhelii* Morelet as a doubtful addition to the list.

TABLE 2—*Summary census of the species of Moorea*

Species	Number adults		Number adolescents		Number embryonic young		Total	
tæniata, D.	32,436	32,440	2,400	2,400	22,332	22,332	57,168	57,172
tæniata, S.	4		.....		.....		4	
suturalis, D.	9,318	14,640	3,495	5,890	7,511	12,922	20,324	33,452
suturalis, S.	5,322		2,395		5,411		13,128	
mooreana, D.	9	5,959	2	546	4	3,737	15	10,242
mooreana, S.	5,950		544		3,733		10,227	
mirabilis, D.	4,620	4,632	437	438	4,205	4,219	9,262	9,289
mirabilis, S.	12		1		14		27	
aurantia, D.	1,622	1,624	626	626	1,457	1,459	3,705	3,709
aurantia, S.	2		.....		2		4	
dendroica, S.	128		233		114		475	
olympia, S.	51		14		44		109	
tohiveana, S.	680		118		627		1,425	
exigua, D.	161		15		115		291	
solitaria, D.	1		.....		1		2	
All.	60,316		10,280		45,570		116,166	

Seven other species are the fruits of my own intensive explorations of Moorea. Four of these were described in 1925, namely, *Partula mirabilis*, *Partula dendroica*, *Partula olympia* and *Partula tohiveana*. Numerous examples of two others have long been in hand, but they have been so puzzling as to require protracted study, which has resulted in their treatment in this volume as independent species—*Partula aurantia* and *Partula exigua*. The tenth species, *Partula solitaria*, is represented by only a single adult individual which is now described for the first time. While it is doubtful practise to base a species on one shell only, I believe that the circumstances in this case justify such a course, which will be fully defended in the descriptive chapter on the species.

The number of Moorean species naturally falls below that of Raiatea, but it exceeds the known series from Tahiti. This may mean that the larger island, so much more extensive than Moorea, has not been as thoroughly explored in the deeper interior as to disclose its full quota of Partulæ. However that may be, it is quite surprising to find so many species in Moorea that were unknown to Garrett and to the other earlier investigators of the Society Islands. The reason why

they escaped prior notice will be dealt with as the novel forms are considered serially, but in general it may be said that the circumstances of their distribution are mainly responsible for failure to find them earlier. Only a close and detailed investigation would have brought them to light.

Each of the ten species presents its own individual features of importance: in intrinsic nature, in distribution, and in its history to the extent that this is decipherable from the data. They fall naturally into a graduated series that begins with *Partula tohiveana*, *Partula olympia* and *Partula solitaria* where the species is represented by small numbers in one contracted geographical situation. *Partula exigua* and *Partula aurantia* come next with wider territories of occupation and with greater abundance. *Partula mirabilis* exists in still more extensive regions, and it leads to *Partula mooreana*, *Partula suturalis* and *Partula tæniata;* the last occurs in considerable numbers everywhere in Moorea where the snails of this genus can live. Each of the ten serves in some way to explain the conditions of another, and everyone is interpretable in some degree by what a different species exhibits. The three long-known species stand out beyond the others, because in their cases it is possible to discover what changes in areal and in constitutional respects have transpired with the passage of time. In view of the importance of the facts, it may be reiterated that in some of the new and in some of the old species it is possible to demonstrate real episodes of organic differentiation in the course of the period over which the investigation has extended.

AREAL RELATIONS

The general description of the areal relations of the several species must begin with a fundamental item of Garrett's work, which constitutes an invaluable basis for the research. This is a simple outline map of Moorea published by Hartman, showing the distribution of the species and of the major varieties of *Partula tæniata* known to Garrett (text-fig. 4). This map is not correct in outline, apparently because there were no accurate charts available to Garrett to provide a copy. Another reason is the interesting psychological fact that less familiar sections are always overestimated in comparison with the better-known areas. The result is that the western portions are much too large relatively, whence Vaianai Valley is brought around to the eastward of the southernmost point, whereas it actually lies to the westward. Again the extreme northwest is greatly exaggerated; this is certain from the identification of the areas marked "no Partulæ," which lie on either side of Faatoai Valley, the headquarters of the variety *nucleola* of *Partula tæniata*.

While it might be difficult to rectify the map on the basis of the outline and sectors alone, the task is facilitated by the verbal statements given in Garrett's large monograph. The corrected chart is given in text-figure 5, without further discussion at this point, inasmuch as each species and its territory will be fully considered in its proper chapter.

The linear arrangement of the localities as listed in the complete census follows an arbitrary geographical order, commencing with the extreme northwestern

member of the outer circle of valleys, Pafatu Valley, and continuing throughout the outer array to Maharepa and Oroau Valleys located on the northern side of the northeastern massif. The sequence is then followed along the inner series of valleys back to the northwest. The valleys of the Rotui sector constitute a third series. By itself this linear order is confusing. Faatoai is the last in the series of inner localities, and thus it stands farthest away from the first of the outer array, namely, Pafatu Valley, whereas the two are geographically adjacent.

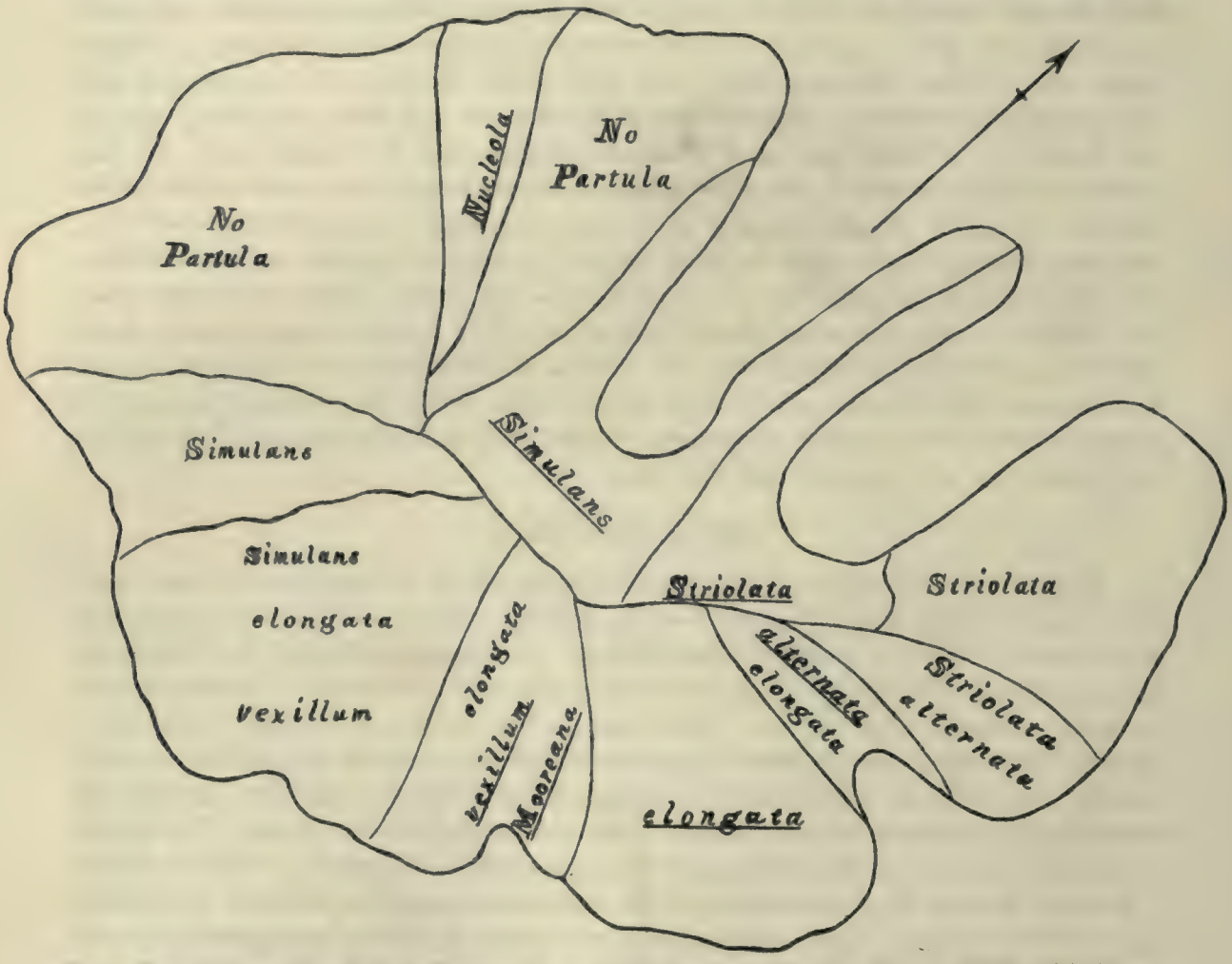


FIG. 4—Garrett's chart of distribution of Moorean Partulæ in his time, as published by Hartman (1882). Original form.

A species common to both circles, such as *Partula mooreana*, will be recorded in two widely separated places in its own columns, while actually two of the localities may be as near to one another as if they were side by side in the same circle, as, for example, Vaianai Valley and Maramu Valley. The real relations are even more obscured in the case of the valleys of the Rotui sector—Matapoopoo is actually close to the Tefeo-Irua section of the inner circle, but in the list it is far removed.

In view of the importance of the real facts, it is desirable at this point to review the areal relations of the several Moorean species. This will have the value of

bringing out the differences between Garrett's determinations and my own, and at the same time it will provide a general perspective on the whole situation in Moorea.

The figures of plate 13, supplementing the entries of the census table (table 1), show graphically how diverse are the areas now occupied by the ten species of Moorea. *Partula tæniata* (fig. A) is uniquitous wherever ecological conditions permit the occurrence of any Partulæ whatsoever; it is true that its representatives are well on their way to distinct specific status, but as yet they must be regarded as the components of a single species. Garrett records an equally extensive terri-

FIG. 5—Corrected form of Garrett's chart (text-fig. 4) showing distribution of Moorean Partulæ in his time.

tory for *tæniata*, but his location of the varieties does not correspond with what exists now, as will appear beyond.

Partula suturalis (plate 13B) stands next in areal extension; this species is much less complex than *tæniata*, as it comprises only two distinguishable varieties. The present area now occupied by the major one of these two varieties notably exceeds the space allotted to it by Garrett. Either it has greatly enlarged its domain in relatively recent times, or else Garrett was not actually conversant with its distribution when he made his observations.

Partula mooreana (plate 13C) also extends at present over wider territory than that assigned to it by Garrett. In this case there is internal evidence that it has expanded its area of occupation in significant ways, even if Garrett's knowledge of its earlier distribution was incomplete.

The new species *Partula mirabilis* (plate 13D) and *Partula aurantia* (plate 13E) possess relatively restricted territories. There is no prior condition in either case with which the present bounds may be compared, but the intrinsic analysis of the material reveals somewhat similar episodes of areal expansion in both cases.

Partula exigua (plate 13C), also a new species of the present research, is interesting because its occurrence in sparse numbers only in the heights of the northeast proves it to be an ancient form whose present representatives have been stranded, so to speak, in a comparatively small area.

Partula dendroica, *Partula tohiveana*, *Partula olympia* and *Partula solitaria* (plate 13F) stand at the opposite extreme from *Partula suturalis* and *Partula tæniata*, confined as they are to a few contiguous valleys in the first case and to single valleys in each of the other instances.

By virtue of the intensive character of the present investigation, the absolute and relative numbers of the tables are generally reliable indications of the real distribution and abundance of the several species. The figures have the positive value of specifying the kinds and numbers which actually have been collected; the absence of an entry in any particular case usually means the non-occurrence of the form in that locality. It is not always so, however, because a given field-trip may have been curtailed by weather or by illness, and the full complement of species may not have been secured. Cases in point are the absence of *Partula suturalis* from the 1907 series from Moruu Valley, and the lack of *suturalis* also in the collection from Temæ, where it undoubtedly exists in the heights. As mentioned earlier, sometimes more attention would be paid to one species in a valley, as in the instance of *Partula tohiveana* in Fareaito Valley. Furthermore the figures could not be exactly comparable unless all of the conditions of collection were identical, such as the number of hours devoted to a single valley, the number of persons engaged in the collection, the climatic circumstances of humidity and temperature during the days preceding the field-trip as well as on the day itself. Hence fewer numbers recorded from a valley may not mean that the snails were any less abundant in that place as compared with another where more were collected. Manifestly all of the conditions could not be identical.

Yet when all qualifications are made, the entries are substantially accurate guides to the presence or absence of the species, and to their relative abundance. In any case the figures constitute a circumstantial description of the material actually analyzed in the present monograph.

ECOLOGY OF THE SPECIES

By virtue of its position within the tropics, its large size, massive construction and height, Moorea provides the necessary complex of conditions required by Partulæ. While other genera of land-snails can avail themselves of lower islands

with more scanty vegetation, *Partula* requires a thick growth of shrubs and trees and the higher degree of moisture which makes such vegetation possible. It is true that the species vary in their tolerance of deviations from the ideal conditions, but there is enough agreement among them to warrant the general statement made.

The volume on the species of Tahiti includes a full discussion of the climatic conditions of the Society Islands in general and of Tahiti in particular, and all that was said about Tahiti holds substantially for Moorea. The temperature, the winds, and the ocean currents have no effects upon the presence of Partulæ, except as they are concerned with the production of the copious rainfall essential for the growth of abundant vegetation.

The botanical conditions are more immediately important. These also have been extensively discussed in the volumes on Tahiti and on the Mariana Islands, whose ecology is very similar to that of the Society Islands. Setchell[1] has recently published an excellent extensive account of the vegetation of the Society Islands, and he has listed the forms of plants from the types of the strand to those of the alternating dryer ridges and moist valleys of the higher interior. With this literature available, we require here only a brief summary of the facts.

The relative dryness and openness of the strand set outward limits to the peripheral extension of the vegetation habitable by Partulæ. The lower portions of the great buttresses that descend from the mountain peaks are devoid of plants other than grasses and xerophytic ferns, except where a few forms like lantana and guava may gain a foothold. These peripheral segments of the buttresses constitute impassable barriers to the passage of Partulæ from one intervening valley to another. Higher up on the ridges, however, the vegetation is thicker, where the moisture is greater; shrubs and trees grow more densely, and they offer a suitable habitation for the snails as well as an avenue of communication from one valley to an adjacent one.

Within the depressed area of a valley itself, the conditions grade from the comparatively open stands of trees toward the mouth to a more or less dense growth of forest in the interior. Three "stories" are distinguishable. The uppermost comprises the leafy spread of lofty trees like the Tahitian chestnut, native plum and native mahogany. The second consists of shrubs and saplings of intermediate height; the climbing and the erect types of pandanus are items of this degree of growth that are much favored as nurse-plants by the Partulæ. The lowest story is occupied by succulent herbs and ferns, and arums of various kinds that are also favorite plants of the snails.

The precise generic names of the plants from which snails were collected are negligible in a sense, because the differences among them bear no relation whatsoever to the diversities of the animals, as long experience has proved. Partulæ feed on decaying vegetation, and the character of the plant which provides this nourishment is a matter of indifference. Snails of totally different species may be found on one and the same leaf of a caladium or huddled together in the bowl of a bird's-nest fern. Where different varieties of a species like *Partula tæniata*

[1] William A. Setchell, *Phytogeographical Notes on Tahiti*, Univ. Calif. Publ. in Botany vol. XII, No. 7, 1926.

occur in the same colony, again a single small plant will harbor unlike snails. Diverse color varieties and animals with sharply contrasted structural characters are also found on one and the same plant or leaf. From these facts, the conclusion is positive that the botanical characters of the vegetation upon which the animals dwell are not essential, provided only that they are the types which grow in sufficient density to afford the necessary amount of shade and the required products of decay for food.

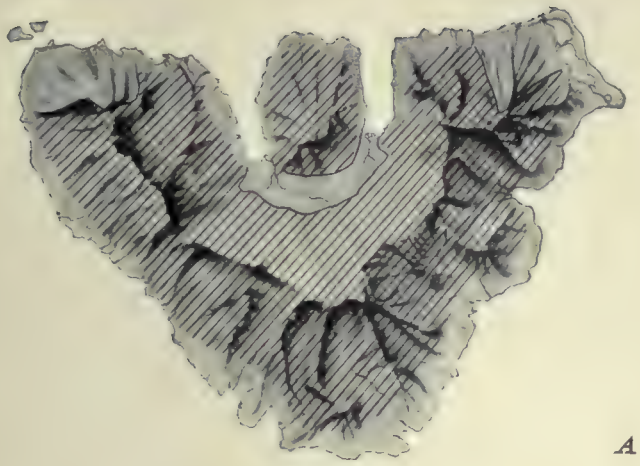
The species of Moorea display some differences in ecological preference, like the species of Tahiti, but these are not so marked or extreme. In the larger island, *Partula producta* was a purely ground type and it has no counterpart in Moorea; *Partula attenuata* preferred the higher branches of trees in the further interior of the island. The range of choice is narrower among the species of Moorea.

The ubiquitous species *Partula tæniata* is like *Partula hyalina* of Tahiti, as it ranges from the highest vegetation to which exploration extended, namely about 1500 feet, down to the very edge of the strand itself where the local topography gave the requisite shade and moisture—for example, along the southwestern shores of Opunohu Bay between Urufara and Aareo Valleys. In contrast, *Partula suturalis* lives generally above a barometric level of 200 feet, and from thence upward to the divides and mountain faces which are not too abrupt to support succulent vegetation. In some valleys where *suturalis* was not encountered until the 500-foot level, it is certain that the species is a new comer.

The relations of the other species are described in detail in the special chapters. Here we may note the sharp restriction of *Partula olympia* to the upper part of Mouaputa Valley, and of *Partula tohiveana* to a similarly contracted area high up in Fareaito Valley. There are no ecological boundaries in these cases to confine the species to their isolated dominions. *Partula dendroica* did not descend below 400 feet above sea-level, although suitable vegetation continued downward in its valleys for a long distance. *Partula exigua* also prefers the heights, and the single example of *Partula solitaria* was certainly found above 500 feet because the mouth of the Taatuapæ division of Faatoai Valley begins at that height.

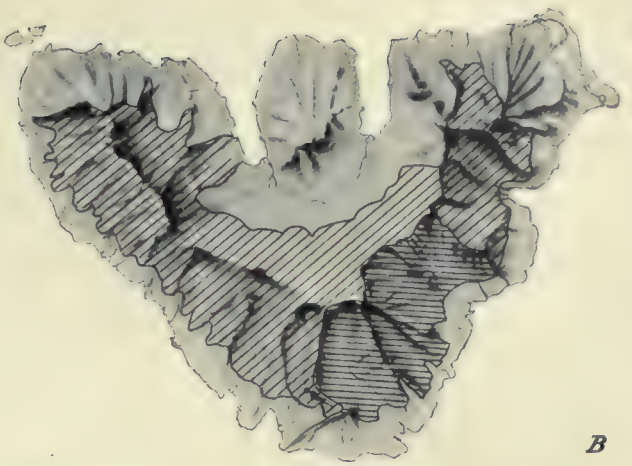
PROBLEM OF THE ENVIRONMENT

In closing this brief discussion of the general distribution and ecological settings of the various species of Moorea, we must stress the significance of the facts for the problem of environmental interposition in determining the qualities of given species or varieties. The census table and the graphic illustrations show how the several forms occupy different parts of the island, varying in their extension and bounds. Surely we can not attribute the qualities of *Partula tæniata* to some peculiar character of the environment which pervades the wide area held by that species. A close study of the circumstances reveals no outward condition in the upper part of Fareaito Valley which would produce *Partula tohiveana* in that locality and nowhere else, especially when other species of totally distinct nature exist there in association with *tohiveana*, and also when all of the ecological conditions of the area in question continue without a break on all sides. The "environ-



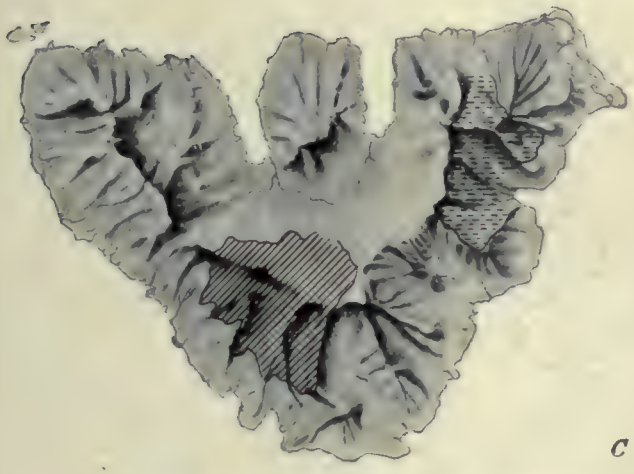
A

Partula tæniata



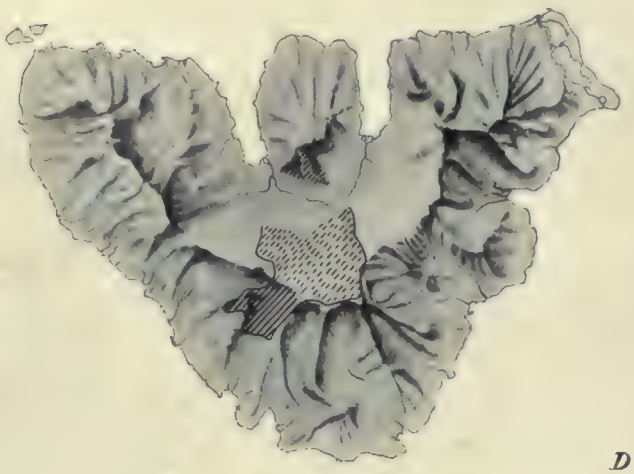
B

Partula suturalis vexillum *Partula suturalis strigosa*



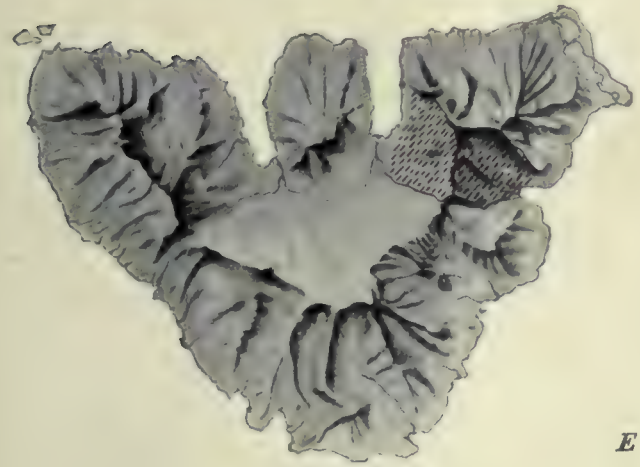
C

Partula mooreana *Partula exigua*



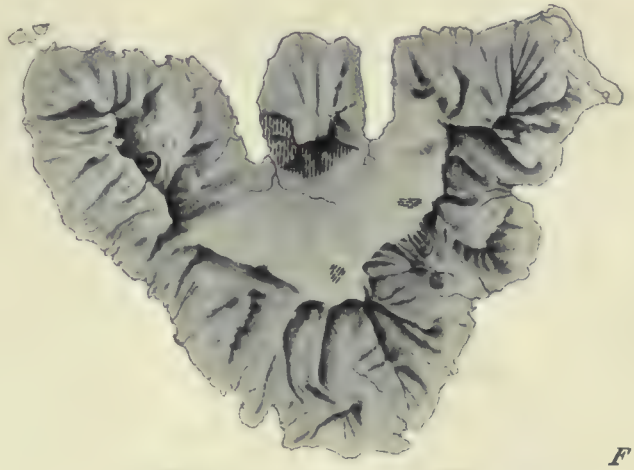
D

Partula mirabilis



E

Partula aurantia



F

Partula dendroica *Partula olympia*

Partula tohiveana *Partula solitaria*

Present distribution of the species of Partula inhabiting Moorea.

ment" enters into the problem only so far as it is suitable or unfavorable for the occurrence of snails whose qualities as such are determined exclusively by their genetic factors.

As we continue with the detailed description of the several species and their various components, I am convinced that the foregoing conclusion will become increasingly clear and sure. We may now address ourselves to this task, taking up the species in an order which commences with the most restricted and simple and concludes with the abundant, complex species *Partula tæniata* which is represented everywhere by one or more of its constituent varieties.

CHAPTER III

PARTULA SOLITARIA new species

When the extensive field studies of 1923 were made, the large valley of Faatoai was examined with particular attention to its subordinate parts. A single adult animal with novel distinctions came to light in a collection from the subsidiary area of Taatuapæ. This proved to be gravid and bore an embryonic young, which likewise presented unusual characters, together with two eggs. Circumstances made it impossible to conduct further explorations in the remote region where the solitary specimen was found. While one is naturally reluctant to establish a full species on the basis of a single adult shell, together with an embryo, yet the manifest characters in this case are clearly distinctive, and the shell is utterly different from anything else that exists in its own area or anywhere else in Moorea. The facts of its existence and nature can not be ignored or passed over, and the only possible course is to treat it as an independent species. In view of the peculiar circumstances, it is named *Partula solitaria* (plate 17, fig. 1). The formal description is as follows:

Shell small, dextral, slender, and elongate-conic but not protracted. Texture thin. Openly umbilicate. Whorls 5½, slightly convex. Suture not impressed. Last whorl flattened on the curve 180° from the margin. Columella straight. Outer surface finely sculptured throughout, and the *inner surface sculptured in the same manner* within the lip.

Aperture elongated and straight. Lip narrow, roundly expanded, and slightly thickened within; the outer insertion meets the body whorl almost squarely. Columellar insertion arcuate. A thin shining callus between the insertions of the lip is rendered evident mainly by decortication of the adjacent outer surface. No tooth.

Color dull corneous, much altered by general decortication. Egg capsule heavily charged with calcareous substance. Egg large, more than 3.5 by 2.5 mm. Embryonic shell light corneous, with high whorls.

Dimensions: Length, 16.0 mm.; width, 8.9 mm.; proportions of shell, 55 per cent; length of aperture, 8.9 mm.; width of aperture, 6.1 mm.; proportions of aperture, 68 per cent; proportions of aperture to shell in length, 55 per cent.

Habitat: Higher portion of the Taatuapæ division of Faatoai Valley, northwestern part of Moorea, Society Islands.

Taatuapæ Valley is the innermost and southernmost division of Faatoai Valley taken as a whole (plate 10A, B). The name is derived from a dominating mountain summit which stands out to the eastward from the main semicircular range. A ridge descends from this peak at first in a northwesterly direction and then turns to the north. Taatuapæ Valley lies behind this ridge and at its foot it meets the lower part of Vaipapa Valley, which is a subsidiary in the western part of Faatoai. As Taatuapæ is the southernmost element of the whole region, its nearest neighbors elsewhere are Vairahi Valley, within the circle of mountains, and Varari Valley on the coastward side.

The collection in which the single example of *P. solitaria* occurred was not made by the author in person, but there is no element of doubt about its locus. With a

trained native assistant who had served me for some years, and with other natives, I had penetrated Faatoai Valley in order to amplify the collections from the Terahimaue division; having completed the immediate task, these natives were started upward from the foot of Taatuapæ Valley with instructions to collect all snails they encountered in the upper reaches. They returned later that day with the material, stating that they had gone up as far as possible through the thick bush of the valley floor. As the starting-point lies at an altitude of about 580 feet, the snails must have come from still higher territory. My assistant in charge of the group had been thoroughly tested, and had proved to be reliable on many occasions when opportunities presented themselves to ignore my directions; no such opportunity existed in this case.

The unique qualities of the *solitaria* shell isolate it from all other kinds in Faatoai and in the northwest generally, as well as from the *Partula* inhabitants elsewhere. The prominent marks of its independent standing are its general form, the flattening of the last whorl on the outer side, its open umbilicus, and the internal sculpturing. I can not recall any shell of another species which shows the last-mentioned character. In addition, the disproportionately large size of the egg is unique; only in *P. fragilis* of Guam is this equalled. The arcuate articulation of the lip at the columellar insertion distinguishes *solitaria* from varieties of *P. tæniata* and from *P. exigua*. The entire complex of qualities marks *solitaria* as a true primary type within the genus, and it can not be ignored, despite the paucity of material.

It is futile to discuss the extrinsic relations of this form without more material which would give some idea of the range of variation of its characters. Obviously it represents a relic which exists in its isolated area in what are probably very sparse numbers. It can not be regarded as a mutant from *P. tæniata nucleola* which abounds here, because it differs in a whole complex of characters and not in one or a few details; the comparison with figures of *nucleola* clearly demonstrates the differences. Search will be made for more material at the earliest opportunity, and it is confidently expected that full justification will be found for the establishment of *P. solitaria* as a distinct species.

CHAPTER IV

PARTULA EXIGUA new species

GENERAL CONSIDERATIONS

The species now to be described for the first time is represented by a small number of individuals taken in some of the areas of the extreme northeastern part of Moorea. In point of abundance in the collections, it stands between *Partula olympia* and *Partula dendroica*. In the extent of its area, it occupies a position between the three species, *Partula solitaria*, *Partula olympia* and *Partula tohiveana*, each of which was found in a single location only, and the other species of the Moorean series with increasingly widened territories. The area of *Partula exigua* very nearly coincides with that of the more abundant species *Partula aurantia*, which is described at length in the chapter on the latter species.

Very few examples were secured in 1907 and 1909, and they were then regarded as variants of the protean *P. tæniata*. When the fuller explorations were made from 1919 to 1924, more abundant material was collected and it became evident that the snails in question were really distinct from *tæniata*, and that they were entitled to full specific status. The animals dwell in the upper reaches of certain valleys of the northeast, where they seem to prefer nurse-plants of the highest growth; for these reasons they escaped the earlier notice of Garrett and of other collectors.

The shell of this species is unusually thin and friable, and the name *Partula exigua* is given on this account. The formal diagnosis is as follows:

Shell small, dextral, fusiform-conic. Texture thin, fragile, and somewhat pellucid. Compressly umbilicate. Whorls 5, slightly convex. Suture slightly impressed and margined with a dull white line. Last whorl flattened near the lip. Columellar relatively straight in most examples. The surface is very finely sculptured throughout, and fine lines of incremental growth are present. Surface shining in general, dulled only in decorticated specimens.

Apertures elongate oval, and almost straight, its plane somewhat inclined backward. Lip very thin and narrow, scarcely thickened within, columellar insertion angled. The lip becomes narrower and thinner toward its outer insertion where it meets the body-whorl obliquely. No tooth.

Colors: Unbanded varieties are corneous, varying from pale and almost white to full color, or corneous brown. A fasciated type with two revolving bands is rare and local. Lip white within and without, rarely with very dilute tints when the shell is well colored. Egg capsule impregnated with calcareous substance.

Average dimensions: Length of shell, 15.23 mm.; width of shell, 8.64 mm.; proportions of shell, 56.70 per cent; length of aperture, 8.48 mm.; width of aperture, 5.99 mm.; proportions of aperture, 70.63 per cent; proportions of aperture length to shell length, 55.56 per cent.

Habitat: Upper portions of valleys of the extreme northeastern part of Moorea, Society Islands, where it is infrequent, on vegetation of higher growth.

AREAL RELATIONS

The general census (table 1) records the absolute and relative numbers in the valleys of the northeast where they occur. The range of *P. exigua* corresponds almost exactly with that of *Partula tæniata striolata*, although the two are entirely unrelated. Only one and two specimens were found in Vaiare-Puutu in 1907 and 1909 respectively (plate 5A), showing that *exigua* must be very rare here or else that the animals hold closely to the highest branches of the trees. None were found in Vaiare-Vaipohe. Three of the four series from Vaiare-Faamaariri (plate 5B) contained *exigua*, while the 1919 series did not. Lower Tepu is devoid of them, as shown by the 1907 series, but in 1919 they were found higher up in the same valley. The species is more abundant in Maharepa, especially in the highest levels where the 1923 series was collected. Oroau and Farehotu are well occupied by Partulæ, but *exigua* was not found. Paraoro yielded satisfactory representations in both divisions; this valley constitutes the end of the range on the inner side. The next valley of Paparoa bears large numbers of *P. aurantia* which are also abundant in Paraoro, but *exigua* does not accompany the other species into Paparoa; it is possible that it does exist in the highest parts of this area, but no specimens were obtained when the valley was penetrated most deeply.

STRUCTURAL CHARACTERS

The qualitative distinctions as given in the formal diagnosis require no extended comment, especially as the general features of the shells are well shown by the specimens of figures 2 to 19, plate 17. The friable texture of the shell and the thinness of the lip are noteworthy, as well as the open character of the aperture.

While the general aspect of an average example suggests an affiliation with *P. tæniata*, the complete independence of *exigua* becomes clearer with closer study. The aperture and lip are much like those of *P. tæniata elongata*, but the other features of the shells differ; the respective territories of these forms are not in contact. Some of the examples of *P. tæniata simulans* from the adjoining valley of Paparoa are like *exigua* in general make-up, but aperture and lip are not the same. The actual associates of *exigua* in the way of *P. tæniata striolata* are decidedly different, and they could not represent the stock from which the present species has arisen. The relation of *exigua* and *striolata* can not be like that of the two varieties of *Partula otaheitana—affinis* and *rubescens*—which exist side by side in a number of valleys of Tahiti.

The quantitative characters are given for all of the measurable shells of this species (table 24), which fairly represent the whole population, although their proportion is reduced by much breakage among the delicate shells. Extreme types as well as average examples are illustrated in plate 17, to show the ranges of the important characters. As only a few shells can be figured, the several features seem to be less consistent than they really are.

The shortest shell (12.6 mm.) is also the narrowest (7.5 mm.) in absolute dimensions (plate 17, fig. 3); this shell also displays the narrowest aperture found (5.3 mm.). The shortest aperture (7.3 mm.) appears in a shell from another

locality (plate 17, fig. 4). The extremes in the matter of the proportions of the shell are 51 per cent and 64 per cent respectively (plate 17, figs. 6, 5). The aperture varies in proportions from 66 per cent to 76 per cent (plate 17, figs. 10, 7).

Owing to the small and scattered numbers of *exigua*, only a few of the series comprise enough individuals to make the statistics significant, when judged by their probable errors. These series agree fairly well in the several characters. The material does not allow for annual comparisons; it must be taken at its positive evidential value with all of the qualifications imposed by scanty numbers.

COLOR CHARACTERS

While the analysis of coloration in *exigua* might be carried to some detail, for the present it will suffice to establish two classes of unfasciated shells and one with banding. The first is called pallida (plate 17, figs. 2–9). Here the shell is typically pale corneous with many or fewer transverse light-brown streaks. When the streaks are few and faint, the shells are consequently much lighter (plate 17, fig. 5) but they are not white, except in decorticated examples (plate 17, fig. 2). Darker tints are due to a greater abundance of the transverse markings (plate 17, figs. 6, 7). In the more pigmented specimens, the apical whorls display a deeper, even color.

TABLE 3—*Partula exigua. Census of the color classes*

Series	Number of adults			
	All	pallida	fulva	frenata
Vaiare-Puutu, 1907	1	1	..	..
Vaiare-Puutu, 1919	2	2	..	..
Vaiare-Faamaariri (A), 1923	5	4	1	..
Vaiare-Faamaariri (B), 1923	4	3	1	..
Vaiare-Faamaariri, 1924	27	23	4	..
Tepu, 1919	15	15	..	..
Maharepa, 1907	2	2	..	..
Maharepa, 1923	41	40	..	1
Paraoro middle, 1909	7	6	1	..
Paraoro, middle, 1923	30	17	7	6
Paraoro south, 1923	27	23	3	1
All	161	136	17	8

The second class is well separated from the first; it is characterized by a pale-brown ground-color, with numerous streaks of deeper brown (plate 17, figs. 10–13); hence it is called fulva, although the tints do not correspond exactly with those of classes belonging to other species, similarly named.

The banded shells are called frenata (plate 17, figs. 14–19) and typically they display two revolving strips of deeper dull brown on a lighter or darker background. The bands are almost evanescent in lighter examples (plate 17, figs. 14-15). This class was represented by a single example in Maharepa (plate 17, fig. 16) and by seven in all in the middle part of Paraoro (plate 17, figs. 14, 15, 17–19). In the latter area two variants of the frenata pattern occurred (plate 17, fig. 18). Another shell from the same locality verges toward the zonata pattern of other species.

Aside from the occurrence of the frenata shells in only two localities, one other feature of distribution calls for comment, namely, the fact that fulva was found in Faamaariri and Paraoro, but not elsewhere; these two localities articulate in the heights, and some amount of inter-communication there would seem to have taken place. The material does not serve for a statistical comparison of the color classes.

EMBRYONIC MATERIAL

While the embryonic material derived from the gravid adults is naturally scanty and irregular, yet the data are positive and they are worthy of record (tables 25, 26). The general averages of productivity conform closely to what are found in other species of Moorea.

As the egg capsules are opaque, *exigua* presents a marked contrast to its associated *P. tæniata striolata*, which almost without exception has a clear capsule. No "anachronisms" in the order of the embryonic contents were observed.

The embryonic shells exhibit very dilute colors, as a rule. Where fulva adults are present in the colony, some of their young are light in color, and some of the young of pallida are brown, thus affording proof that the two classes interbreed. None of the young of frenata parents displayed bands, and none of the young of plain parents were striped; thus it would appear that the fasciated pattern is established by resolution of an original even color.

SUMMARY AND CONCLUSION

The present species exists in relatively small numbers in a series of more or less contiguous valleys of the northeastern part of Moorea. Its representation in the collections is small, partly because the animals live in the highest portions of the valleys on lofty vegetation, and doubtless also because they are not actually abundant. The species offers an interesting parallel to *P. attenuata* of Tahiti and Raiatea in these respects.

Despite its superficial resemblance to varieties of *P. tæniata*, *P. exigua* is actually entitled to full status as a species, for its whole complex of characters is not duplicated elsewhere. Its small size, delicate texture, and peculiar aperture are its most distinctive features.

While it may have originated in the past from the same ancestor as *P. tæniata*, the characters of *P. exigua* make it more probable that it is more intimately related to *P. attenuata*, which it resembles in its ecology. If further study confirms this view, then we would have additional evidence of the existence of a prior land-mass of large size, of which the present Society Islands are the remains. Whereas the ancestral stock which ranged over this whole mass has remained unchanged, as *P. attenuata*, in the present islands of Tahiti and Raiatea, in the intermediate island of Moorea its descendants have gradually gained the differential characters of *P. exigua* of today. Although the case of *P. attenuata* is unassailable, the significance of the Moorean element in the situation should not be too highly estimated in advance of further investigation.

CHAPTER V

PARTULA TOHIVEANA Crampton

GENERAL CONSIDERATIONS

As the species of Moorea are treated in a general order that begins with those having the simplest conditions and smallest areas of occupancy, *Partula tohiveana* might well have followed *Partula solitaria*. But its numbers are substantially greater than those of *Partula exigua* and its diverse color types are more clearly distinguished. On both of these accounts it demands more extended discussion than the subject of the previous chapter. Altogether it well deserves the somewhat detailed description here given.

Its area of occupation is smaller than in any other cases except *Partula olympia* and *Partula solitaria*, and its component varieties are few, being exceeded in all other species except one only. Furthermore the discussion is limited to the nature and condition of the species at the end of the whole period of the research, for it was not until the intensive explorations of 1923 were made that *tohiveana* came to light in a small forested area near the foot of the steep slopes of Mount Tohivea, on the northward or Opunohu side. More ample collections were taken subsequently in the same year, and still greater numbers were secured in 1924. Despite the small area of its habitation and the lack of an opportunity to compare the present condition of the species with what it was in earlier times, nevertheless the novel characters of the shells, their diversification, and their structural relations to certain Raiatea species, combine to make *Partula tohiveana* extremely interesting on its own merits as well as valuable in comparative connections.

On account of its special interests, *Partula tohiveana* has already been formally recorded, together with certain other new forms of its island.[1] The original description is here quoted, with minor elisions and with the dimensional characters omitted inasmuch as these are given in fuller detail in the present work:

"Shell large, sinistral, elongate-conic, and perforate. Whorls 5 to 5½, with flattened profile at the apex, becoming more convex with further growth; suture slightly impressed in most examples. The middle area of the last whorl is flattened or even indented immediately outside of the lip. Columella straight. The dense, finely sculptured lines of the younger whorls disappear toward the body-whorl, which is therefore smooth and shining in undecorticated specimens.

"Aperture elongated, with its long axis inclined away from the columellar axis. Lip rounded or slightly beveled, thickened inwardly, sharply angled at the columellar insertion, and dentated near its outer insertion; the toothed appearance is accentuated by the sudden narrowing of the peristome toward its junction with the last whorl. A thin, shining callus spreads over the body-whorl between the two insertions of the lip. A parietal tooth is almost universally well developed.

"Colors: (*a*) Corneous yellow or light corneous brown, with or without darker coloring of the apical whorls, and in some specimens with sparse darker transverse lines; (*b*) similar in ground color, and with two, sometimes four, vaguely defined revolving bands

[1] H. E. Crampton, *New and significant species of Partula from Moorea, Society Islands*, Nautilus, vol. xxxvii, Apr. 1924.

of chocolate brown; (*c*) with a revolving median zone of chocolate brown upon the usual background. The lip is white, smooth and shining.

"The shells of half-grown individuals have the outer wall plainly angled, although this feature disappears on the later-formed whorls. The embryonic young are always unbanded, either white or faintly corneous, with or without a colored tip. The bands of fasciated individuals appear only in post-embryonic life, and they seem to be relics of an antecedent dark general color. Embryonic capsule impregnated with calcareous substance so as to be opaque.

"Habitat: Moorea, Society Islands; lower slopes of Mount Tohivea."

There can be no doubt that Garrett remained in complete ignorance of the existence of this species. Its characters are striking and clearly distinctive, and had he found it he could not have confused it with any other form, such as *Partula suturalis*. The full reasons for this conviction are given elsewhere, but one of them is especially noteworthy, namely, the circumstantial statement by Garrett in his discussion of *Partula suturalis* that "no reversed Partulæ were found in any other part of the island except on the western side of the stream in Vaianai (Valley), and the . . . stragglers taken on the opposite coast." Of course, the representatives of the sinistral species *Partula mooreana* are elsewhere explicitly recognized as colonists in Vaianai. Clearly, then, Garrett did not visit the small territory where *tohiveana* dwelt in his time; whether or not the limits of the area so occupied were exactly the same as they are now is a minor and negligible point. All of the circumstances indicate that the single known colony of *tohiveana* in Fareaito Valley is fairly stable both as to its numerical equilibrium as a whole and as regards its area of occurrence. Hence it stands in sharp contrast with many of the other species of Moorea, such as *P. mooreana*, *P. suturalis* and *P. mirabilis*, whose geographical spread and morphological differentiation during proximate decades have been most extraordinary.

AREAL RELATIONS

The region called Fareaito by the natives of Moorea is close to the high dominating semicircle of mountains, and near the eastern end of Mount Tohivea, on the inner or Opunohu side (plate 7A, text-fig. 2). The valley itself is not a deep depression, but there is a distinct ridge that intervenes between Fareaito and Irua to the east, while a more rounded buttress separates Fareaito from Tefeo to the west. The upper portion of the dry and unforested ridge called Tamaruohue sharply divides lower Fareaito from lower Tefeo. In Fareaito itself the terrain slopes toward the mountains at an angle of about 20° from the horizontal, up to about 700 feet above sea-level, beyond which it becomes much steeper and rougher; above 1000 feet of altitude it rises more abruptly and merges into the precipices of the mountain wall. The forests of Fareaito Valley are of medium density, and plants of the Pandanus family are especially plentiful. On the contiguous ridges of higher altitude the vegetation is a little more sparse, but it is not interrupted by treeless areas.

The territory occupied by *P. tohiveana* begins at about 675 feet to 700 feet above the level of the sea, and extends upward to at least 1100 feet; its lateral

boundaries are only 400 yards apart and are quite as well defined as the lower limit. Yet the forests are unbroken toward the eastern region of Irua and the westward territory of Tefeo; there are no ecological barriers of any kind which might prevent the animals of this species from extending their horizontal range, as there are in the case of the similarly restricted *P. salifana* of Guam. Likewise there are no surrounding circumstances that account for the sharp line of its lower limit; the associated species *P. tæniata*, *P. suturalis* and *P. mirabilis* range outward on all sides without any indication of restricting ecological barriers.

The collections forming the basis of the present description and discussion comprise 680 adults, 118 partly grown individuals, and 627 young, or 1425 in all. The first named constitute 26.78 per cent of the adult *Partula* population of Fareaito Valley, as represented by the combined collections of 1923 and 1924 (table 1). But this relative figure must be taken as only an approximate index of the frequency of *tohiveana*, for specific reasons. On the day of the first discovery (July 5, 1923), every specimen of every species was collected in working up from lower Fareaito into what proved to be the lower portion of the territory occupied by *tohiveana*; 841 adults were secured, of which 50, or 5.95 per cent, belonged to the novel species. On the following day another representative series was taken in the middle level of the area where the species occurs and, on account of its interest, the new form received more attention than its associates; in this series, *tohiveana* numbered 228 out of 273 adults, or 61.12 per cent. In 1924 Fareaito Valley was revisited, collections were made up to still higher levels, and the outer borders of the range were finally determined; at that time 402 among 1332 adults were *tohiveana*, or 30.11 per cent. When all of the circumstances are taken into account and the actual figures of relative frequency are duly qualified, 20 to 25 per cent would seem to be a just estimate of the abundance of *tohiveana*, *in that portion of Fareaito Valley which it actually inhabits*.

STRUCTURAL CHARACTERS

The general morphological features of *P. tohiveana* as recorded in the diagnostic description are amply illustrated by the shells of plate 17, figures 20 to 34. The animals are generally larger than in any other species of the island. The coil is exclusively sinistral. The uninflated conical form of the spire is an important distinction, and the outline of the lip with its dentated border is particularly noteworthy.

The statistical description of *tohiveana* further characterizes the species in quantitative detail (table 27). The data serve for (1) a definite comparison of the species with others of its own island and elsewhere, (2) for the comparison of the three areal associations, and (3) for the comparison of the distinguishable color groups. As a whole, the species exhibits a rather wide amplitude of variation, in its proportionate measures as well as in the absolute dimensions.

One shell among the 680 adults presents an extraordinary mutation in the matter of size, as it is a definite dwarf (plate 17, fig. 29). It is certainly an example of *tohiveana*, for it displays all of the distinctive characters except the large size, and its coloration is likewise typical of a color class of *tohiveana*. The smaller associ-

ated species are dextral, namely, *P. suturalis*, *P. mirabilis* and *P. tæniata*, and they are quite different in many respects other than the direction of the coil; hence the specimen in question can not be a reversed sport from one of these. The sinistral *P. mooreana* does not range as far eastward as Fareaito Valley, and even if it did the peculiar shell would be recognized as something other than *mooreana*. The mutant differs from the lowest member of the continuous array by the following degrees: length, 1.2 mm.; width, 0.6 mm.; length of aperture, 0.8 mm.; one other shell is equally narrow in the aperture. As compared with the average figures for the several characters, of course the differences are much greater. A final point in this connection is that the novel shell appeared in the midst of a normal colony, all of whose members were unquestionably subjected to identical environmental conditions; the factors that produced it could not be other than internal and spontaneous.

Other unusual shells which must be called aberrant rather than abnormal are not infrequent; they differ from average specimens in an absolute measure, or in some one of the proportions such as the shell of figure 30, plate 17, or in the "set" of the aperture (plate 17, fig. 21). One true abnormality was found where a half-grown adolescent had changed the character of the later whorls when they were added (plate 17, fig. 32). Only one shell possessed a slightly deformed lip; it is not illustrated.

The internal analysis of the material begins with the recognition of three territorial series taken respectively from the lower, middle and upper levels of the compact area where *tohiveana* occurs. It is of course inevitable that the "middle" series must include some specimens taken on the way upward, and that the "upper" series will comprise a few individuals actually belonging to the middle and lower levels. As the distinguishable series prove to be different in certain respects, it follows that the actual degrees of difference must be greater than they appear to be. However, the discussion may well confine itself to the returns, with the above considerations kept in mind; the discussion itself is concerned with the possible participation of environmental influences in determining the collective variations exhibited by the shells.

When the three subordinate series are analyzed biometrically, they vary in a very interesting way (table 27). Taking first the measures of the whole shell, the absolute figures drop in going from the lower to the middle section, and increase in the next step upward; but the proportionate measures *increase* when the same order is followed. The absolute measures of the aperture correspond with those of the entire shell, but the proportionate measure *decreases* consistently from the lowest level upward. Finally the proportion of the aperture to the whole shell as regards length regularly increases from below upward, although the differences are not as clearly significant as in the other comparisons.

It is obvious that the several characters of the shells vary independently and without relation to external circumstances. It is not reasonable to suppose that the latter could be essentially diverse within the limits of the small area, only a few hundred yards in any diameter, where *tohiveana* dwells. The outstanding point of interest is that the different sections of the whole colony do disclose variations

in structural respects, existing as they must under virtually identical conditions of soil, nurse-plants, moisture and sunlight.

The parietal tooth (table 28) is developed to some extent in every single shell. The average degree of its growth diminishes consistently as we pass from the lower to the higher levels, and here too the reasons would seem to be innate rather than external. In the absence of a single shell without this feature, and in the abundance of shells with its high development, *Partula tohiveana* is a unique species of Moorea.

COLOR CHARACTERS

The shells resolve themselves into three primary color groups, or color classes, and two of these are divided into secondary sections or color orders. The numerical representations of the resulting five kinds of coloration are given in table 4.

Nearly four-fifths belong to the class of unfasciated shells designated **inornata**, and this group is divided almost equally into the order **inornata simplex** (plate 17, figs. 20, 21) with uniformly colored spire, and the order **inornata apex** (plate 17, figs. 22-24), in which the first-formed whorls are tinted with brown. The ground-color is typically corneous white in the adolescents and young adults, but decortication frequently takes place and the older adults are usually much whiter, especially on the body-whorl. Among the **inornata apex** shells are many that display transverse, irregular streaks of brown which are quite independent of the cortex, as they plainly show in decorticated specimens with a white background (plate 17, fig. 24). At the outset, these were distinguished as a separate group under the name **strigata**, which has real standing in other species of Moorea and Tahiti; but the shells in question grade continuously from the plain extreme to a distinctly marked form in such a way as to justify their inclusion in one comprehensive class. It is true, however, that the strigations appear among the **apex** shells more frequently than in the **simplex** order (table 4).

TABLE 4—*P. tohiveana. Census of the color classes and color orders*

	Absolute numbers											
	Lower (July 5, 1923)			Middle (July 6, 1923)			Upper (June 23, 1924)			All series		
	simplex	apex	all	simplex	apex	all	simplex	apex	all	simplex	apex	all
inornata	11	20	31	85	90	175	179	146	325	275	256	531
frenata	10	9	19	18	34	52	36	41	77	64	84	148
cestata	.....	.....	.....	.....	1	1	.....	.....	.....	.....	1	1
Total	21	29	50	103	125	228	215	187	402	339	341	680
	Percentages											
inornata	22	40	62	37.3	39.4	76.7	44.6	36.3	80.9	40.4	37.7	78.1
frenata	20	18	38	7.9	15.0	22.9	8.9	10.2	19.1	9.4	12.4	21.8
cestata	.....	.....	.....	.....	0.4	0.4	.....	.....	.....	.....	0.1	0.1
Total	42	58	100	45.2	54.8	100	53.5	46.5	100	49.8	50.2	100

The class called **frenata** is characterized by two revolving bands (plate 17, figs. 25-29, 31), which appear first on the metaneanic whorls to gain in strength and distinctness on the larger whorls; almost invariably the lower band is wider and deeper in color than the upper band. The background of these shells may be of light flesh color, or browner and more streaked; when decortication has occurred, the bands stand our prominently on a white background (plate 17, figs. 26, 27). In this class also two color orders are distinguished, as **simplex** and **apex**, according to the absence or presence of a darker apical coloration. In a few cases a basal band is added (plate 17, figs. 28, 29). The late appearance of the bands in **frenata** shells is to be emphasized, in view of a contrasted history in *Partula olympia*.

Only one shell was found that showed a wide median zone of brown color, hence to be called **cestata** (plate 17, fig. 30). Its peculiar coloration is in a sense to be derived from the **frenata** pattern, for the lower border of the zone of color corresponds with the lower band of **frenata**. This single **cestata** shell has a dark apex, and deep basal color as well.

The shells of the distinguishable color groups do not occur in uniform proportions throughout the area of habitation, small as this is. From the census table (table 4) it is clear that the **frenata** shells are progressively less abundant as we pass from the lower to the upper portions of Fareaito Valley; specifically the percentages are 38, 22.9, and 19 respectively. The apical darkening also shows a decrease, from 58 per cent to 54.8 per cent, and finally to 46 per cent; but the two classes are not alike. In **inornata** the dark apical coloration decreases from 40 per cent to 36 per cent in the ascending geographical order; but in **frenata** this feature shows a relative increase. The net result is that the relations of the **simplex** and **apex** orders is completely reversed, when the lower and upper subdivisions are compared. To state the facts in another way, we may say that the preponderating color class of the lower level, namely **inornata**, gains over **frenata** as we pass upward, and at the same time it changes from an excess of the color order **apex** to a preponderance of the color order **simplex**. It is clear that the ordinal distinctions and the class distinctions are independent in their inheritance. Furthermore it must be conceded, I believe, that all of the characters in question are congenital, and that no environmental circumstances can be held responsible for the differences in their manifestation within the confines of so restricted an area as the one in question.

EMBRYONIC MATERIAL

In its viviparous habits, *Partula tohiveana* agrees with all other known species of the genus. The egg-capsule displays the calcareous impregnation of the walls which is characteristic of the larger and more solid species of *Partula*.

The statistics of fecundity (tables 29, 30) show an average figure of 2.26 embryonic items for the gravid individuals, which amount to 553 out of 646 recorded adults, or 85.6 per cent. The reproductive rate of the whole series, namely 1.93, is low as compared with that of most species, and it may be that this is responsible for the failure of *tohiveana* to extend its range beyond its present limits. However, no general conclusion can be drawn from the few data available, for the figures

relate to only three dates of the same season of the two latest years of investigation. What the facts may be for other seasons of the year can only be conjectured.

The embryonic contents of three gravid individuals gave evidence that in rare instances an egg fails to be fertilized. An apparent "anachronism" in the order of the embryonic items is the result. The three records are as follows, with the oldest item given first: (1) young, egg, young; (2) egg, young, egg; (3) egg, egg, young. Real anachronisms have been found in other species, but in the present cases fertilization has not taken place.

It seems strange that the series of July 6, 1923, should differ from that of the preceding day, both as to the relative number of gravid individuals and also as regards the proportionate number of young and eggs. Apparently the animals living in the middle area had engaged actively in reproduction before those of the lowermost area; in consequence the latter would naturally have more eggs than young, and more of them would be gravid. If this is indeed the correct reason, then it means that collective variation from place to place in a physiological respect is real, like variation in structure and in coloration.

So far as the data of heredity are concerned, one assured fact appears, namely that all of the 627 young are sinistral, like the animals of older growth.

The colors of the embryonic shells are "white," "tinted," or "colored with colored apex"; not a single one displays revolving bands or stripes, and hence the **frenata** and **cestata** patterns are post-embryonic features, as the adolescent shells also indicate. The embryos with colored tips are clearly destined to become **apex.** The distinctive feature of this order is an hereditary character, for the figures of table 31 show that the young produced by **apex** adults are more often provided with the colored tip than are those of **simplex** parents. The proportion of the **simplex** to the **apex** type is slightly higher among the young than it is in the case of the adults which bear young; taking the facts at their face value, this may be accounted for by a late appearance of the apical darkening in some individuals, although it is conceivable that the whole community is slowly changing in the direction of the **simplex** type. The former seems more likely, but the question can be answered finally only by procuring collections in future years.

While it is obvious that snails of the **simplex** and **apex** types can interbreed, it is not possible to prove from the returns that the **inornata** and **frenata** color classes are similarly unhampered in their matings, because the distinctions in question appear only in post-embryonic life. There is every presumption, however, that interbreeding on the part of all of the various color types proceeds without restraint.

SUMMARY AND CONCLUSION

Because *Partula tohiveana* was found only during the latest years of the present study, its analysis and interpretation can not be so broad and detailed as in the case of a more abundant species of long standing in the records. Yet its intrinsic features are by no means devoid of general interest.

The area of habitation is extremely restricted, and this accounts for Garrett's failure to discover it and also for my own ignorance of its existence until the most

intensive explorations of 1923 and 1924 were made. Immediately the question arises whether the single known association of *tohiveana* is the product of spontaneous mutation from another form of Moorea, or whether it is a surviving relic of a species, or group of species, which was more widely distributed in bygone times, and which was not immediately connected with the progenitors of the other species now existing in Moorea.

In the first place, the appearance of several distinguishable color patterns indicates an association of considerable age, whose past history has been long enough to permit such diverse color types to become established. Secondly, the differences between *tohiveana* and any other species of Moorea are so wide as to exclude the suggestion of a *proximate* common ancestry with any one of them. It is true that *P. olympia*, *P. mooreana* and *P. dendroica*, as well as many representatives of *P. suturalis*, are sinistral; but it is no more justifiable to regard such agreements as indicating a recent common ancestry for all of these kinds than it would be to assert that *P. tæniata* and the dextral members of *P. suturalis* are immediately related, because they are alike in the direct mode of coil.

The third point is more important. In the earlier description, considerable emphasis has been put upon the dentated or key-holed aperture of *tohiveana*. This feature is prominently displayed by a group of forms living in the island of Raiatea, possessing other likenesses as well which signify their close relationship; they are *callifera*, *dentifera*, *formosa* and *imperforata*, whose respective standings as species or sub-species are matters of secondary importance in comparison with their substantial likenesses. The Raiatea species are all dextral. Accepting the agreements of *tohiveana* with the Raiatea forms as evidences of relationships, the next point is that the former could not be the descendant of immigrants from Raiatea, changed in the direction of the coil, any more than *callifera* and *dentifera* and the rest could be the offspring of *tohiveana*-like migrants from Moorea. The only tenable conclusion, in my opinion, is that Moorea and Raiatea were connected by land in ancient geological times, that a parental stock ancestral to the species now under discussion ranged widely over this land-mass, and that by subsidence the extreme areas which are now the islands of Moorea and Raiatea became isolated. The existing representatives of this stock remaining in Raiatea continued their history of differentiation to become the present forms of that island, dextral in spirality; the survivors in Moorea, having changed to the reversed mode of coil as some colonies of *P. suturalis* have done in recent decades, dwindled until their sole remaining representatives became the small relic of the present *tohiveana* association.

CHAPTER VI

PARTULA OLYMPIA Crampton

GENERAL CONSIDERATIONS

Like the species of the foregoing chapter, *Partula olympia* is a new discovery of the later years of the present investigation; therefore the sole task is to deal with the intrinsic qualities of the animals and with their geographical situation, on their direct evidential merits. There is no earlier basis for comparison either in the records of Garrett or in my own prior observations.

The area of habitation is small and remote from the present dwelling places of the natives. The first examples were discovered on August 25, 1919, on the inner slopes of Mount Mouaputa, in the high forests of the valley with the same name as this dominating peak. Only four adults and one immature individual were found; and at that time they were erroneously supposed to be very specialized aberrant members of *Partula suturalis*. Two days later trustworthy natives were sent into Mouaputa Valley, and among the animals they secured were 47 adults and 13 adolescents like my earlier specimens. It was then apparent that the peculiar forms constituted a distinct group of true specific status. Their associates in the way of orthodox *suturalis* and of *tæniata* corresponded perfectly with what I had found two days before, and there is no doubt that the natives had revisited the exact locality where the first individuals had been found. In 1923 an effort to return to this locality was rendered futile by adverse weather and the sudden onset of illness; again in 1924 serious illness made it impossible to revisit the area where *olympia* is known to dwell. While the collections in hand are scanty, yet they comprise enough individuals for a basic diagnosis and analysis.

On account of its special interest, *Partula olympia* has already been formally recorded, together with *P. tohiveana* and other species.[1] The original description, with certain details omitted, is as follows:

"Shell sinistral, ovate-conic, more compact than in *P. tohiveana;* compressly perforate. Whorls 5 to 5¼, convex throughout, suture of the body-whorl impressed. The middle part of the last whorl is depressed just before it meets the flaring lip, as in *tohiveana.* Columella twisted slightly—a feature more evident in adolescent than in adult shells. The spiral sculpturing continues from the youngest whorls to the very edge of the lip.

"Aperture elliptical, axis parallel to the columellar axis. Lip rounded or slightly beveled, thickened inwardly, broad at its columellar insertion and narrowed toward its outer insertion, but not so markedly as in *tohiveana.* A shining callus occurs between the two insertions, finely pitted under the lens. A parietal tooth occurs in all but a few shells, but it is not prominent.

"Colors: (*a*) Uniform fleshy corneous; (*b*) uniform medium brown; (*c*) same in basis, with a median band of brown on the whorls of the spire only; (*d*) similar in ground-color, with a vague median band of brown which extends over the body-whorl as well as on the upper coils; (*e*) ground-color as before, with two revolving bands of brown, weak and vaguely defined. The lip is white.

[1]Nautilus, vol. XXXVII, 1924.

"The outer wall of the adolescent shell displays a median angle. The revolving colors of fasciated individuals appear on the embryonic shell, in which respect they differ from the bands of deeper tint in *tohiveana*. The embryonic capsule is opaque.

"Habitat: Moorea, Society Islands; inner slopes of Mount Mouaputa, at high levels."

AREAL RELATIONS

Mount Mouaputa is one of the dominating peaks of the great crescentic wall that partly encloses the open areas of Paopao and Opunohu (plates 1, 7A). On its inner side, the fan-shaped valley of Mouaputa is bounded peripherally by the sector of the ancient crater wall that extends from Mount Tohivea to Mount Mouaputa; its northern limit is a huge buttress that descends abruptly to about the 500-foot level, below which it debouches with easier gradient into the Paopao basin. This ridge is forested above, but clothed with grass and xerophytic ferns below Mouapu—a peculiar pinnacle of rock that serves as a distinctive landmark in this territory. To the south, the valley is limited laterally in its lower levels by a similar dry ridge which separates the forests of Mouaputa Valley from those of Poua Valley. At 700 to 800 feet, however, the higher forests are continuous with those of Paparoa to the north and of Poua to the south, along the lower talus slopes of the massive crater wall. The *olympia* colony is located in the approximate center of Mouaputa Valley, above the 800-foot barometric level; its associates of other species extend on all sides in such a way as to prove the absence of ecological barriers which, if they existed, might be held responsible for the narrow localization of the *olympia* colony.

STRUCTURAL CHARACTERS

As regards the qualities of form and size, the shells of this species are adequately described by the numerical data of the original diagnosis, by the full statistics of table 32, and by the illustrations of plate 17, figures 35 to 47. In general the average shell is smaller than that of *tohiveana*, shorter and stouter than *P. suturalis*, while in some respects it resembles the larger examples of *P. mooreana* in ways that point to a common ancestry with that species—a topic to be discussed beyond. While almost any one of the structural features of *olympia* might be duplicated in some variant of another species, yet the whole combination is sufficiently distinctive to mark it as a true species.

The available material comprises fewer specimens than in any other case except the special one of *Partula solitaria*, because the area of habitation is extremely small and also because the species is not abundant in that area. When it was first discovered in 1919, the adults numbered 4 out of 279 of all species, or 1.43 per cent; the second collection taken two days later included 621 adults in all, of which 47, or 7.57 per cent, belonged to the novel species. In effect, therefore, the statistical characters are determined almost wholly by the second collection.

Under the circumstances, the summary quantitative description (table 32) is valuable mainly for the comparison of *olympia* with other species of its island. The few shells of the first day's collection prove to be well within the range of variation of the second day's series. On the whole the variability of the several characters is lower than in the case of *tohiveana*.

The parietal tooth is generally present (table 33), but its average degree of development is low. In these respects *olympia* presents a decided contrast to *tohiveana*.

COLOR CHARACTERS

Partula olympia is isolated from all other species by its characteristics of coloration; some of the patterns are not unique, it is true, but the whole complex of color characters is distinctively different from anything found elsewhere. There are four color classes represented, and one of these is divisible into color orders; the existence of five types of coloration is an indication, among others, that the species has long since gained its independent status, and that it has not originated during recent decades from some other of its own island.

TABLE 5—*Partula olympia, Mouaputa Valley. Census of the color types*

Series	cestata vera		cestata helix		carnea		castanea		frenata		Total	
	Adult	Immature	Adult	Immature	Adult	Immature	Adult	Immature	Adult	Immature	Adult	Immature
Aug. 25, 1919	.....	.....	1	1	3	.....	.....	.....	.....	.....	4	1
Aug. 27, 1919	19	5	18	3	5	2	1	1	4	2	47	13
All	19	5	19	4	8	2	1	1	4	2	51	14

The most abundant and most typical color class, **cestata** (table 5), is fleshy-corneous in ground-tint, with a median revolving band of brown; the distinctive zone is deeper in color and more sharply defined on the apical whorls. In the color order called **cestata vera** (plate 17, figs. 40, 41), the girdle extends over the last whorl, but it is progressively weaker and more vague in outline as full growth is attained. In the color order named **cestata helix** (plate 17, figs. 42-44), the distinctive zone disappears as early as the metaneanic whorls.

Unbanded individuals occur in smaller relative numbers; most of them display the same general ground-color as the former, and are called **carnea** (plate 17, figs. 35-37). Many of this class are so completely decorticated as to appear white, but the adolescent and embryonic material proves that the original color is the kind indicated by the class name. The color class called **castanea** (plate 17, figs. 38, 39) is represented by one adult and one immature individual, which are definitely brown.

The final class is called **frenata** (plate 17, figs. 45-47) because it exhibits two revolving bands of color, like so many of the shells of *P. tohiveana*. These bands are not closely related to the broad zone of the **cestata** type. In the first place, the apex is brownish and unstriped; the bands appear only on the intermediate whorls, while on the final ones they *increase* in strength and definition, although they never become as plain as the zone of color on the apical whorls of **cestata**. The upper band of **frenata** does correspond with the upper margin of the girdle in **cestata**, but the lower strip of **frenata** lies outside of the area of that zone, and hence it appears in oral aspect below the point marked by the outer insertion of the lip. A com-

parison of figures 41 and 46, plate 17, clearly establishes the difference in question. Hence **cestata** and **frenata** are not as directly related as they would seem to be at first sight; the latter is probably nearer to **castanea** in origin.

So far as the intrinsic statistical analysis is concerned (table 32), it appears that the two **cestata** orders agree closely throughout, while the **carnea** class is somewhat divergent. The **frenata** specimens are too few to warrant any definite statements.

EMBRYONIC MATERIAL

The rate of reproduction corresponds with that of other species, so far as the scanty data are indicative (tables 34, 35). As the egg shell is impregnated with calcareous material which disappears only when the embryonic shell is formed, there is a clear classification of items into eggs and young. About 84 per cent of the adults were gravid, and the average yield was a little more than two. All of the young were sinistral, like all of the individuals of older growth.

The unborn snails are most useful in connection with the analysis of coloration (table 36). They fall into two categories, the first of which comprises beautifully and distinctly banded individuals, clearly destined to become **cestata vera** or **cestata helix** adults, according to the degree to which the colored girdle keeps pace with the whole shell as it grows. The second group includes unbanded shells, light or dark corneous in color, which correspond with the protoconchs of **carnea**, **castanea** and **frenata**. When the full statistics are tabulated (table 36), it is evident that most of the young of **cestata** parents are banded, but others are plain; unbanded adults of the **carnea** and **castanea** classes produce a majority of plain young, but accompanying these are others which are certainly **cestata**. The young of **frenata** show a slight excess of definite **cestata** young. Obviously the several classes interbreed. The data are too scanty to show whether or not the contrasted qualities behave in Mendelian ways.

From the summary (table 36), it appears that the proportions of **cestata** young to plain young are substantially similar to the relations of the corresponding classes of adults; hence the color composition of the colony as a whole seems to be stable, so far as the limited observations go.

SUMMARY AND CONCLUSION

While the general value and significance of the present species are greatly qualified by its small numbers and by the lack of an earlier basis for comparison, yet it displays several features of real interest. Its contracted area of habitation is noteworthy, particularly as this is devoid of ecological limits which might prevent *olympia* from extending its range into adjoining forests. The sole known community seems to be the reduced remnant of an ancestral stock which may well have extended widely and in greater numbers over Moorea, in former times. This colony is therefore similar in a general way to *P. tohiveana* of the same island, *P. filosa* in Tahiti, and *P. salifana* in Guam.

An inquiry into the antecedent history of *P. olympia* involves the primary question of its real specific status, for if it is merely a varietal relative of some

other species of Moorea, the problem of its origin would have a very simple solution. But every comparison with the other species of Moorea strengthens the conviction that it is actually distinct and a primary type within the genus. Its sinistral coil seems to ally it with *tohiveana*, *dendroica* and *mooreana*; but the remarkable history of *P. suturalis*, as related in a subsequent chapter, proves that an exclusively sinistral group can arise from dextral antecedents, while the analysis of the abundant varieties of *P. otaheitana* gives the same result in another island. Without elaborating the discussion, it may be said that *P. olympia*, despite the above agreements in the matter of coil, is separated from any one of the other species mentioned by the whole complex of its characters, *viz*, compact form, rounded lip, and in the earliest possible appearance of median coloration when this occurs.

The next question is whether the ancestral stock from which *olympia* has sprung also produced other descendants which now inhabit Moorea as a contrasted species, or whether we must look to another island for an existing type to which *olympia* is more nearly related than to some species of its own island. The latter was the case in *tohiveana*. All in all, the typical shell of this species is nearest to an average specimen of *P. mooreana*. Hence it seems most probable that *olympia* and *mooreana* are the independent descendants of an earlier single stock which spread widely over the island at some time in the past, but which disappeared for the most part, leaving *olympia* in its restricted territory and *mooreana* in Vaianai Valley. The former now survives as a relic colony whose scanty numbers maintain a precarious position in nature; the latter, as a subsequent chapter demonstrates, has recently gained new vigor, and has overflowed into other areas of Moorea, producing new variants in the process.

CHAPTER VII

PARTULA DENDROICA Crampton

GENERAL CONSIDERATIONS

In contrast with the two forms last described, the beautiful species *Partula dendroica* is found in a series of four localities in the sector of Mount Rotui; its total area of occupation, however, is notably less than that of any other among the remaining species of Moorea. Despite its large size and distinctive qualities, it was unknown to Garrett and to other former workers in Moorea, partly because its habitation is somewhat contracted and secluded and also because its numbers are sparse. Furthermore the snails seem to prefer the vegetation of higher growth and hence are not as readily found as are the animals of other species in Moorea; the habit is not unique, for *Partula attenuata* of Tahiti and Raiatea is similarly a dweller in the upper parts of the larger trees. The name of the present species has been given in recognition of its habit, which incidentally is accountable for the fact that more adolescents than adults were taken—233 as compared with 128; the younger individuals are more active and come down to lower herbage than do the full-grown animals.

The Rotui sector is entirely devoid of representatives of *P. suturalis*, with which the present species might easily be confused on slight acquaintance; the contrasts are nevertheless quite evident when full series of shells are examined, and there can be no doubt that *dendroica* is entitled to true specific status. Perhaps its most striking feature is its extraordinary diversification in the characters of coloration to a degree that is truly remarkable in view of the small size of the areas in which it occurs.

The original description of *P. dendroica* as already recorded[1] is here repeated with the omission of the dimensions and certain minor details.

"Shell sinistral, oblong-conic, compressly perforate. Whorls 5¼ to 5½, slightly convex, the last conspicuously slender. Suture impressed, more markedly on the last whorls. Columella sinuous. Surface shining and generally smooth, as if polished; spiral sculpturing weak, and obsolescent on the last whorl.

"Aperture oval, not inclined. Lip rounded, slightly thickened within, channeled at its columellar junction, and evenly curving to the neighborhood of its outer insertion, where it turns inward more abruptly. The callus over the body-whorl is very thin. Parietal tooth entirely wanting, or very weakly developed in a small percentage of the specimens.

"The color classes are clearly differentiated, as follows: (*a*) uniform light straw-yellow, with slightly darkened tip as a rule; (*b*) uniform yellowish brown, or brown; (*c*) yellowish brown, with a single median band of deep brown, sharply defined on all excepting the youngest of the whorls; (*d*) like the foregoing in ground-color with a broad median zone of deep brown color; (*e*) yellowish brown or brown, with four revolving bands of deeper brown, one near the suture, one near the base, and two intermediate.

"The metaneanic whorls are not angled as in *tohiveana* and *olympia*. Fasciation begins with the embryonic stages. The embryonic capsule is opaque.

"Habitat: Moorea, Society Islands; southern and southwestern aspects of Mount Rotui, at high levels."

[1]Nautilus, vol. xxxvii, 1924.

AREAL RELATIONS

The geographical circumstances merit a careful description. Mount Rotui is the great mass that lies between the bays of Opunohu and Paopao (plate 1); its highest point is approximately 2930 feet above sea-level. This peak stands well to the south and hence the southern aspect of Rotui is very steep (plate 11B). The eastern and western sides (plate 11A) are also very abrupt, but the slopes from the summit to the shore are more gradual to the north (plate 4B). It follows that the valleys of the northern side are longer and shallower, with easier gradient, while the western, eastern and southern valleys are short in radial extent, steep in slope and small in area. The thicker growth of trees and shrubs is strongly conditioned by these topographic features and by the prevailing winds and rains. Most of the time the rain beats upon the southern, southeastern and southwestern faces of Rotui, and in consequence the forests are more abundant there. But the forests are limited to somewhat rhomboidal areas as they are bounded above by the steep cliffs of the high mountain walls, laterally by dryer buttresses of rock-dike and bare slope, and by the peneplain of low levels at the base. These rhomboidal areas of forest where *dendroica* lives are connected horizontally by very narrow strips of vegetation, usually at about the 500 foot barometric level; hence communication between contiguous valleys is rendered difficult and slow. The region as a whole is isolated from the major crescent of mountains by the broad, low basins of Oponohu and Paopao Valleys.

The four valleys inhabited by *P. dendroica* are Vaihiaiia, Matapoopoo, Tepatu and Pupuhi-Teviroa. The first is situated in the southwestern part of the sector (plate 11A). The forests of its northern portion are thick and directly continuous with those of Vaihere, but nevertheless *dendroica* has not availed itself of this open way, and it does not extend beyond Vaihiaiia, so far as careful observation goes. In Vaihiaiia the present species was first encountered at the 150-foot level, and it extended upward to at least 500 feet above the sea. Matapoopoo ("the shadowed aspect") faces almost directly south, and its forested area well exemplifies the description given in the preceding paragraph. While other species range down to 100 feet, *dendroica* lives here only above the 200-foot level. Tepatu Valley (plate 11B) is likewise typical, but strangely enough the animals of the present species do not descend here below the altitude of 400 feet. Pupuhi-Teviroa is more open (plate 11B), and while it is well limited to the south, on the north its forest growth merges more broadly with that of the Marure region. Yet *dendroica* ceases quite as abruptly on this eastern side of Rotui as it does on the western side. The illustration shows how Pupuhi-Teviroa is corrugated inwardly by abrupt vertical ridges of rock which partly but not completely divide its forests. Matapoopoo and Vaihiaiia are similar.

The census of the species (table 1) reveals a greater relative abundance of *dendroica* in the extreme valleys of its range as compared with the central territory of Matapoopoo. The figures must be used with caution, however, because recent years have witnessed an extraordinary increase in the numbers of *P. mirabilis* in Matapoopoo Valley; it is quite probable that the absolute abundance of *dendroica* in Matapoopoo is not sensibly less than in the adjoining valleys.

STRUCTURAL CHARACTERS

The most obvious general feature of *P. dendroica* is its sinistral nature, in which it agrees with the two new species already described, as well as with the majority of *P. mooreana*. While its numerical representation is not high, yet all individuals of all ages, amounting to 475, are reversed.

Full-grown shells are large, slender and graceful in form (plate 17, figs. 48-51; plate 18, figs. 1-18). In general aspect *P. dendroica* resembles *P. suturalis* more than any other species of the genus in Moorea or elsewhere, and the likenesses clearly indicate an ultimate common ancestry. Nevertheless the former must be regarded as a distinct species and not as a mere variety of *suturalis*, on account of its consistent differences in structure, and also because it displays a peculiar series of color characters. The relation between *dendroica* and *suturalis* is strikingly parallel to that of *P. otaheitana* and *P. producta* in the Tahitian fauna, and there are similar relationships exhibited by species of Raiatea.

For the greater part, the quantitative analysis deals with collections taken during the later years of study. One small lot was secured in Vaihiaiia in 1909, it is true, but in the middle portion of that valley, while in 1923 and 1924 the southern and northern subdivisions of Vaihiaiia were explored. Hence it is not possible to deal with the question of colonial change with the lapse of time, as in the case of species later to be considered.

On account of its importance as a distinct species, the statistical analysis of the several colonies of *dendroica* has been carried out in detail, even though the numbers are small in most instances (table 37). The several colonies vary in all respects of size and proportions, as we pass from one to another of the four inhabited valleys, in correspondence with the separation of the forested areas where the animals live. Naturally the degrees of difference are not as great as those exhibited by the numerous colonies of such a species as *P. suturalis*, where the geographical distances are larger.

The full statistical description shows that there is considerable amplitude in the absolute variation of the several qualities; yet the averages are strikingly consistent throughout the whole array of primary and secondary associations. When the progressive geographical comparisons are worked out (table 38), there are very few differences that are statistically significant, although several more are *possibly* indicative of real structural unlikeness. The noteworthy instances are (1) the diminished length of the Pupuhi-Teviroa shells as compared with those of Tepatu, very close by; (2) the narrow character of the shells in western Matapoopoo as compared with southern Vaihaiaiia; and (3) the differences displayed by the Vaihiaiia subcolonies in respect to the proportion of the aperture. It is conceded, of course, that the figures for the 1909 series of Vaihiaiia are not as trustworthy as if they related to a collection taken between 1919 and 1924, because some change might have taken place in the interim; but they have some value, even if it is qualified.

The parietal tooth is very weakly developed in *dendroica* (table 39). Very few possess it at all, and when it appears it never attains an index value higher

than that of the second class. Only in certain varieties of the composite species *Partula tæniata* is this feature so little in evidence. Only one shell was found which was abnormal in the form of the lip (plate 18, fig. 9).

COLOR CHARACTERS

The color classes of *dendroica* number seven in all and their census is given in table 6. The most abundant type, called **cingulata**, is distinguished by a narrow, seal-brown revolving band in the median position (plate 18, figs. 4-10). This band extends from the extreme apex to the lip; it appears above the suture on the larger whorls, that is, it is not overlaid by the new coils as they are added. The ground-color in this class is almost invariably light yellowish or fuscous, and hence the characteristic band stands out sharply. This type preponderates in the extreme valleys—Vaihiaiia and Pupuhi-Teviroa—and it is distinctly less abundant in the

TABLE 6—*Partula dendroica. Census of the color classes*

Series	cingulata		cestata		zonata		quadriga		apex		fusca		castanea		Total	
	Adult	Adol.	Adult	Adol.	Adult	Adol.	Adult	Adol.	Adult	Adol.	Adult	Adol.	Adult	Adol.	Adult	Adol.
Vaihiaiia north, 1924	12	8	.....	.....	.....	.....	.....	.....	2	.....	.....	.....	1	2	15	10
Vaihiaiia middle, 1909	6	11	.....	.....	.....	.....	.....	5	.....	.....	7	12	.....	.....	13	28
Vaihiaiia south, 1923	8	13	.....	.....	2	2	2	17	2	7	2	5	1	3	17	47
Matapoopoo west, 1923	.....	.....	.....	.....	2	.....	1	2	3	7	.....	.....	.....	.....	6	9
Matapoopoo middle, 1919	1	2	4	1	2	.....	5	.....	1	.....	.....	.....	.....	.....	13	3
Matapoopoo east, 1923	.....	.....	.....	.....	1	.....	.....	.....	.....	1	.....	.....	.....	.....	1	1
Tepatu, 1923	4	5	4	3	6	5	8	1	7	9	.....	.....	.....	.....	29	23
Pupuhi-Teviroa, 1923	15	44	.....	.....	.....	.....	.....	.....	19	68	.....	.....	.....	.....	34	112
All	46	83	8	4	13	7	16	25	34	92	9	17	2	5	128	233

intervening areas. The definitive coloration of this class appears in full in the earliest shelled stages, and it is the only fasciated pattern of *dendroica* that does manifest itself as early as embryonic life; in this respect it is similar to the **cestata** pattern of *P. olympia*.

In another striped class, **cestata** (plate 18, figs. 11, 12), the shells display a broad median girdle of deep brown color, which is not merely a widened counterpart of the **cingulata** stripe, for only its lower border coincides in position with the latter. Usually in shells of this class there is a vague colored zone below the suture and more or less basal darkening as well. The whole pattern is developed only on the metaneanic whorls by resolution of a general brownish color, as the embryonic material clearly proves.

The class called **zonata** (plate 18, figs. 13, 14) is somewhat similar, but the girdle of color is so wide as to appear in oral view below the insertion of the lip, while the basal area of brown is widened to leave only a narrow strip of the lighter ground-color between it and the median band. This class, like **cestata**, gains its pattern only during post-embryonic life.

Another striped class occurs which is really distinct, but closely related to **cestata** and **zonata**. This is called **quadriga** (plate 18, figs. 15-18) on account of the

four revolving lines of deep brown that extend from the apical coils over the rest of the shell. If only the median lines were present, this type would be named **frenata**, as in *P. tohiveana* and *P. suturalis*, but the invariable presence of the subsutural and basal stripes marks it as something different. Clearly **quadriga** is allied to **zonata**, in so far as the median lines correspond with the borders of the wide zone of the latter, while the outer elements of the pattern are much the same. Again, the apical whorls are uniform brown, so this pattern also is established by resolution.

Unstriped shells exist which fall into three classes. The first of these is **apex** (plate 17, figs. 48-50) where the general ground-color is light fleshy-yellow and the smallest whorls are slightly darkened. This class was found in all localities. The class distinguished as **fusca** (plate 17, fig. 51; plate 18, figs. 1, 2) is browner, with a deep-colored apex as before. Adolescent shells display fine transverse lines of brown which apparently broaden in later life to give a more diffused dark color to the whorls of adult shells. This type was collected only in Vaihiaiia. Finally, in Vaihiaiia again, a very few shells were found which were deep chestnut brown; these are named **castanea** (plate 18, fig. 3). They present a sharp contrast to the other bandless kinds and with the striped classes as well, for the color does not agree with that of the rich seal brown, revolving stripes of the fasciated classes.

In review, the **cingulata** class stands apart from all of the other six, through its possession of a narrow stripe which is produced upon the very earliest whorls. All other types are derived from an embryonic coloration that is uniform and lighter or darker in tint. When the color lightens subsequently to some degree, the **apex** and **fusca** types are developed; when the uniform embryonic brown of deep tint persists, the result is **castánea**; and when deep embryonic brown breaks up during further growth, the **cestata**, **zonata** and **quadriga** patterns are the outcome, by different modes of resolution.

Because the color classes are numerous and the material is not abundant, there are small numbers to represent their respective groups when these are statistically contrasted (table 40). The figures have some value, however, which may be estimated in terms of their probable errors. The purpose of such a detailed analysis is to ascertain whether any one class is a quasi-independent strain, differentiated from its fellows in structural characters as well as in coloration, in such a way as to be in process of becoming a distinct *variety* in the future; but nothing of this kind is disclosed. For example, if the **apex** class be compared with its associates in the several localities, it is sometimes larger and sometimes relatively smaller; the same is true of the **cingulata** class. We may therefore conclude that the characters of structure and of color are fortuitously combined in various ways as the chances of interbreeding and hereditary procedure may direct.

It is almost superfluous to point out that the distinctive features of the several color classes, and their varying combinations from locality to locality, can not be attributed to differing external influences when these must be identical in all four of the inhabited regions. It can not be contended that the presence of **cingulata** and of **apex** in all areas means similar environmental factors for their occurrence, or that the presence of **cestata** in Matapoopoo and Tepatu could be due to an

external circumstance which operates in these two valleys but not in Vaihiaiia or Pupuhi-Teviroa. Clearly congenital factors only are responsible for the qualities in question and for the sinistral coil as well; there are dextral associates of *dendroica* in the same valleys, and it would certainly be illogical to contend that the *same* environment could be responsible for the *opposite* directions of spirality in the contrasted species.

EMBRYONIC MATERIAL

In all cases the representative collections were taken during the calendar summer months; hence the statistics of fecundity (tables 41, 42) relate to only one period of the year and no data are at hand for a comparison with other seasons. Taking the records as they stand, the proportion of gravid individuals (80 per cent) is a little less than in other species of the larger and more solid type, while the average number of embryonic items (3.24) is a little larger than usual.

The reversed mode of coil is invariable among the young, which amount to 134. Therefore *dendroica* aligns itself with *tohiveana* and *olympia* as regards the strict inheritance of the sinistral character.

The inheritance of the several distinctive color patterns is a subject of much interest, and the statistics given in table 43 are satisfactory enough to lead to certain definite conclusions. A prior point established earlier may well be recalled at this juncture, namely, that the **cingulata** pattern is the only one among the fasciated types that shows on the youngest whorls; the others come about by resolution of an early dark color.

There are two associations made up entirely of **cingulata** and **apex** adults, namely, those of northern Vaihiaiia and of Pupuhi-Teviroa. In the embryonic array taken from the first named, all of the young are banded **cingulata**; while in the case of the latter, banded and plain young occur in about equal numbers. Thus there is no doubt whatever that these two classes interbreed, while the facts indicate also that the **cingulata** pattern behaves as a dominant. Other series confirm these conclusions. In the middle part of Vaihiaiia, the **cingulata** and **fusca** classes were found; half of the young of **fusca** parents were banded and hence this class also proves to intercross with **cingulata**. The **quadriga** adults of southern Vaihiaiia produced two banded offspring with narrow stripes of the **cingulata** type. In Tepatu, the **zonata** adults bore a majority of plain young, together with four **cingulata** young; the **quadriga** parents of the same locality likewise prove to interbreed with **cingulata**. In summary, the data show that the **cingulata** type intercrosses with all others except **castanea**, for which case there are no facts. Owing to the late appearance of the definitive qualities of the classes other than **cingulata**, it can not be determined whether such classes also interbreed freely with one another as they do with **cingulata**; it is a fair presumption that they are mutually compatible in a reproductive sense.

The **cingulata** pattern prevails among the young of parents belonging to that class and among the young of their associates to such a degree that we may regard this type as a Mendelian dominant; it is true that the data are scanty, and that the conclusion can not be held as established without actual breeding experiments.

SUMMARY AND CONCLUSION

In contrast with the sharply restricted species treated earlier, *Partula dendroica* occupies four major areas; however, these areas are small and contiguous, and hence the total extent of its territory is notably less than that of any one of the species still to be considered. Within this territory, the colonies vary in morphological respects and in coloration, without relation to surrounding circumstances. The factors of variation are congenital, so far as any information can be obtained.

Despite its small numbers, *P. dendroica* is greatly diversified in its characters of color, no less than seven definite types being displayed. Most of these have counterparts in some other species, and more frequently in colonies of *P. suturalis*. But their combination is quite as diagnostic as the details of structural difference. The existence of so many color types indicates a considerable age of the species.

In its exclusive sinistral character, *P. dendroica* resembles *tohiveana* and *olympia*; but in its general morphology it is more nearly related to *P. suturalis*. It is impossible that *dendroica* could have arisen recently by mutation from another species of its own Rotui sector for there is nothing here from which it could have sprung. Its ally, *suturalis*, now ranging through the valleys of the great crescent of mountains, is effectually barred by the lowlands of Opunohu and Paopao from sending migrants into the Rotui sector. We may interpret the likenesses displayed by *dendroica* and *suturalis* as indications of their independent derivation from a common ancestral stock, spread widely over Moorea at a geologic time of the past when this island had not diminished by erosion and subsided to its present level, and when forests of dense growth and of higher altitude stretched between the heights of Rotui and the loftier mountains of the old crater wall. As subsidence progressed, the lower open valleys of Opunohu and Paopao became dryer, and their forests disappeared; consequently the members of the antecendent stock which dwelt in the Rotui sector were isolated, and they proceeded along their own lines of evolutionary modification to become *Partula dendroica* of today. There is no question that they have gained the full status of a species, for their characters are consistent and definite. The mere fact of their geographical isolation is a circumstance, and not the sole criterion, of their independent position.

CHAPTER VIII

PARTULA AURANTIA new species

GENERAL CONSIDERATIONS

The species now described for the first time comes next in order by virtue of its larger area of occupation and its greater numbers. It exists today in considerable abundance in certain valleys of the northeastern portion of Moorea. It was first found in 1909, but was not recorded in 1924 when other new species were described because there were many perplexing points in its intrinsic nature and in its distribution that demanded further study.

The material now in hand comprises 1624 adults, 626 adolescent snails, and 1459 embryonic young, making 3709 individuals in all. The animals were collected in Paraoro and Paparoa Valleys within the circle of mountains, and in Vaiare-Vaipohe and Vaiare-Faaraariri on the outer side. The first two areas are of major status; the latter are large, but in effect subdivisions of Vaiare taken as a primary physiographic element. In the course of the years of field-work, ten series in all have been collected; the times and areas are fully recorded in the general census table (table 1).

This species is now so abundant and so well represented in its easily accessible territory that its discovery only as late as my own researches is much more notable than in the case of such an isolated species as *tohiveana* or *olympia*. Although Garrett must have visited the valleys where it now exists in some profusion, apparently he did not find it; he makes no mention of its like, and I have failed to find a single specimen of *P. aurantia* in his own collections in the museums of Honolulu, Cambridge, Philadelphia, Pittsburgh, and elsewhere. Another point is that he wrote to Hartman in 1879 explicitly stating that he (Garrett) had sent to Hartman representatives of every species existing in Moorea.[1] From time to time others have collected in Moorea but they also must have missed the territory of *aurantia*, because there is no item in the literature that refers to its kind of shell, and furthermore no specimen of the species can be found in the various collections of America and Europe that I have seen. These circumstances are partly explained by the facts hereinafter recorded which make it clear, as I believe, that *aurantia* has spread into much of its present territory only in most recent years; in earlier times it was undoubtedly restricted to so small an area as to escape all but the closest search, which apparently was not made. Hence its condition must have been similar to that of *tohiveana*; but while the latter has remained as it was, *P. aurantia* has increased in numbers and invaded adjacent regions, although unquestionably the environmental circumstances have remained the same.

This species has received its name on account of the general russet orange-brown color of some of its most abundant classes; it is formally characterized as follows, although the brief diagnostic description is greatly amplified by details recorded later and by the illustrations of plate 18, figures 19-48.

[1]Quoted by Smith, Annals Carnegie Mus., vol. I, 1902, p. 450.

Shell elongate-conic, openly perforate; dextral except in very rare instances. Whorls 5 to 5½, slightly convex; suture not impressed. Columella somewhat plicate. The revolving incised sculpturing becomes coarser and less evident on the last whorl, except on the base in the neighborhood of the umbilicus, and hence the largest whorls are smooth and shining. Surface marked with transverse incremental lines, but not rugose.

Aperture relatively small and narrowly oblong, though highly variable. Lip beveled, thickened inwardly, strong at its outer insertion and plicate at the columella. Parietal tooth generally absent or very weakly developed.

Colors: (*a*) plain, fuscous orange brown to deeper brown, with vague transverse lines of brown, well spaced; (*b*) same in ground-color with three definite revolving brown bands, and with a basal band as well in some cases; (*c*) with two revolving bands of brown, the upper being narrower and the lower broader, rarely with the additional basal band; (*d*) usually paler in general color, with a broad median zone of deep brown, intact or "split" longitudinally; (*e*) uniform seal brown.

The whorls of young adolescent shells are sharply angled, but the older ones are rounded. Embryonic shells usually unbanded, rarely banded. Embryonic capsule opaque, impregnated with calcareous substance.

Habitat (1924): Northeastern part of Moorea, upper areas of Paraoro Valley, most of Paparoa Valley, and local portions of Vaiare Valley.

AREAL RELATIONS

The present distribution of *aurantia* and the interpretation of its recent history in spatial respects require a thorough knowledge of the geography of its territory (plate 13E). The great crescent of high mountains culminates at its northeastern end in a mass of which Mount Tearai is the dominating element, 2583 feet in height (plates 1, 5B). Tearai is in effect a massive panel running east and west, forming the southern boundary of Maharepa Valley. Southwest from Tearai a principal ridge descends abruptly for about a thousand feet, to continue as the divide between Vaiare Valley on its eastern side and the other two valleys inhabited by *aurantia* on the west (plate 5A). At Farataupoo the height is 1567 feet, while it is 1230 feet at Faraieie which constitutes, as it were, a northern gate-post of a high pass. This pass from Vaiare to Paparoa, namely, Tepuutiafa, has an altitude at its crest of 1093 feet. Continuing southward the ridge gains height rapidly to Popoeretia (1803 feet), and then merges upward into the prominent mountain of Mouaputa (2633 feet).

Vaiare Valley is subdivided into three main components by ridges that descend from Farataupoo and from Popoeretia. The northern component, Faamaariri, and the middle element, Vaipohe, are inhabited by *aurantia*, while the southern division, Puutu, did not yield any snails of this species.

On the western side a ridge trends westward from Faraieie to separate the northern valley of Paraoro from the proximate southern area of Paparoa. The ridge in question drops rapidly for some distance to become a saddlelike divide between the two valleys, after which it ascends to a sharp-pointed hill of at least 800 feet altitude, bare of high vegetation, whose slopes to the west constitute the barrier between the lower portions of Paraoro and Paparoa.

Vegetation is continuous at the pass between Vaiare-Vaipohe and Paparoa (plate 12B), and is similarly unbroken from upper Paraoro to Vaiare-Faamaariri.

Along the dividing ridge in the western direction, there is no break in the continuity of high vegetation between upper Paparoa and Mouaputa Valleys, but *aurantia* has not been found in the latter, which is the home of *P. olympia*. At lower levels, the divide between Mouaputa and Paparoa is bare of high growth and forms an effective obstacle to the migration of *aurantia* from the latter to the former. Regarding the contact of Paraoro and Paparoa, it is clear that free passage is possible at the heights as far down as the low saddle mentioned above; but toward the shore it is not possible for snails to spread in either direction. A final point is that the vegetation of upper Paraoro is continuous with that of Farehotu Valley, immediately adjoining to the north; but despite the absence of an ecological barrier, *aurantia* does not appear in the last-named territory.

We now turn to the significance of these facts. The problem of the geographic history of *aurantia* begins with the fact that it was undiscovered by Garrett, although it is practically certain that he entered all three valleys under consideration, because the *tæniata* which he locates in these valleys now exist in substantial correspondence with what he described.

The proportionate numbers of *aurantia* in the whole populations of the three areas provide pertinent data for the problem. Beginning with Paraoro, the figures are 38 per cent for 1909 and 42 per cent for 1923; and although the difference is small, yet it seems to indicate a relative increase of the present species during the interval of 14 years. It is true, of course, that a reduction in numbers of the *tæniata* would give the same numerical result, and it is also true that *aurantia* lives at higher levels than *tæniata*, so that if the series of 1909 had been taken in the lower valley while that of 1923 had been secured higher up, the observed difference would be noted. But the ground covered in the two years was actually the same. When all discounts are allowed, it would seem reasonable to conclude that there had been a slight increase of *aurantia* here; and this indicates its entrance into Paraoro at a slightly earlier date.

When we pass to Paparoa, the facts are clear and decisive. In 1907 no *aurantia* was found in the lower part. In 1909 it was taken at higher levels in the interior, where it formed 76 per cent of the whole *Partula* population. In 1919 it was still absent from the lower forests, while in a small series taken that year in the higher interior, it was present to the extent of 70 per cent. When the fuller collection of 1923 was secured, quite unexpectedly it was discovered that *aurantia* had worked its way down the center of the valley to the flat floor, scarcely 25 feet above sea-level, and to the very borders of the major stream of the Paopao region. There is no evidence that surrounding conditions had changed during late decades to be more favorable for migration than before; the proof is clear that in recent years *aurantia* has actively and spontaneously expanded its area of occupation in this valley.

The data for the Vaiare region are also significant in certain respects. No representatives of the species were found in Puutu, either in 1909 or in 1919. In the 1919 series from the Vaipohe division, *aurantia* amounts to 44 per cent of the population, but it formed only 5 per cent of the 1923 series from the same section—

a discrepancy due to the fact that in the earlier year collections were taken from the halfway point up to the divide, while in 1923 only the lower portion of the valley was visited. The figures for Faamaariri differ for similar reasons. The series of 1919 and of November 1923 were secured lower down, and *aurantia* does not appear in these; but in the series of October 1923 and of 1924, taken at higher altitudes, the species amounts to 14 per cent and 9 per cent of the populations, respectively. The very fact that *aurantia* is not uniformly distributed in the whole area of Vaiare Valley is itself proof that the species has not existed in this region long enough to become equally represented everywhere.

The conclusion of the whole matter is that the area of habitation of *aurantia* has been greatly enlarged since the species somewhat suddenly entered upon a period of geographical expansion, probably about 25 or 30 years ago. Its migration down the whole length of Paparoa Valley is not deduced, but actually demonstrated. The absence of ecological barriers between Paraoro and Farehotu, and between the upper portions of Paparoa and Mouaputa, proves the recent advance of *aurantia* to the indicated bounds. There are small relative numbers in the mid-levels of Vaiare-Vaipohe and Vaiare-Faamaariri, and hence the recent occupation of these regions is shown. And although a forested way extends from upper Vaipohe to upper Puutu, the species has so recently reached the former point that as yet it has not availed itself of the opportunity to migrate farther.

The prior headquarters, closely restricted as late as Garrett's time, was probably located near the center of the present more extensive territory; and when all of the topographical, botanical and barometric facts are taken into account, this center may be placed with some confidence in northern Paparoa, at mid-level, not very far from the low saddlelike divide between Paparoa and Paraoro to the north.

STRUCTURAL CHARACTERS

The snails herein treated as a species are distinguished from all others by their whole complex of morphological characters and by the series of color types as well. In the matter of size, some of the larger specimens approach *P. suturalis*, which is an associate in some localities, while others grade down almost to the lesser bulk of *P. mirabilis*; collectively, the species is practically intermediate between these two. Aside from coloration, the most distinctive features are displayed by the aperture which is generally narrow, squared, small, and beveled at its borders, although in all of these respects it is highly variable, even in a single community. The soft parts of the various species of *Partula* are to be made the subject of a separate study; but at this point it is interesting to note that the foot of *aurantia* presents a characteristic form, and it is also curiously pigmented along a zone a little within the margin, in a way that is unique.

The dextral form of the shell is almost universal; only two adult individuals were found that were reversed (plate 18, figs. 47, 48). The first was a member of the 1909 series from Paparoa, while the second was taken in southern Paraoro Valley in 1923. Not only are these areas well separated in distance, but there is also a definite dry barrier between them. It is therefore certain that the two aberrant

individuals were independently produced by mutation from dextral parents; they can not be members of a sparsely distributed sinistral strain of this species. The specimen from Paparoa Valley contained two embryonic young, sinistral like itself. Had this adult remained unmolested in its area, the young might well have carried on the novel character so as to establish a new stock, increasing in numbers. The two reversed adult snails were found in a total collection of the species amounting to more than 1600 snails; it is not unreasonable to suppose that their like may be produced sporadically at other times and places, and that intensive exploration in the future will discover reversed associations of *aurantia*.

The fundamental data relating to the morphology of this species, as given in the descriptive tables, refer to the prevalent dextral shells. The class ranges, mean values, and standard deviations of the several characters are given in table 44 for the several associations as entireties. In table 45, which records the mean values of the characters, the several color classes are defined as well as the total series; and the same extensive record is made of the standard deviations (table 46). Progressive annual and geographic differences, with their errors, are given in table 47. The figures for the entire series of 1380 measurable dextral adults afford a basis for comparison of *aurantia* with other species of Moorea, described in the same way.

Considering first the several colonies taken as wholes, it appears from the records that the 1923 series from middle Paraoro differs from the lot taken in 1909 in the same area, to significant degrees in six of the seven characters. Apparently some hereditary diminution in all of the absolute dimensions took place in the interval, with changes in the proportionate characters as well. The southern Paraoro series of 1923 is collectively nearer to the Paparoa colonies, which may mean that immigrants from the latter have continued to add themselves to the descendants of the first waves. It is interesting that the Paparoa colonies of 1909, 1919 and 1923 are slightly different, but they show no consistent trend of colonial modification with the passage of time.

The Vaiare series are important. The first evident point is that the shells from Faamaariri are smaller than those of Vaipohe. Furthermore the former more closely resemble the Paraoro shells, while the latter are more like the Paparoa groups. These relations indicate that the two divisions of Vaiare have been independently populated from across the divide, although we must allow for some intermixture of the two streams of migration in the heights near the pass of Tepuutiafa.

Despite the large general size of the shells, the parietal tooth is relatively weak in its development (table 48). Indeed about three-fifths of all shells are devoid of this morphological feature; and in those that are credited with a small tooth, the structure is only a weak trace and not prominent. The Paparoa colony of 1909 is notable for the occurrence of as many as 14 individuals with a definitely large tooth, and doubtless these were intimately related genetically.

The exceptional sinistral shells are clearly independent in their mutative origin from dextral antecedents, as attested by the geographic and time elements.

Their measurable characters are correspondingly unlike. In terms of the values of the classes into which they fall, the characters of the two are as follows:

Character	Paparoa, 1909	Paraoro south, 1923
Shell, length	19.25 mm.	18.95 mm.
width	10.70 mm.	10.30 mm.
proportions	55.5 p. ct.	54.5 p. ct.
Aperture, length	9.90 mm.	9.30 mm.
width	7.30 mm.	6.90 mm.
proportions	74.5 p. ct.	73.5 p. ct.
Length aperture ÷ length, shell, proportions	51.5 p. ct.	48.5 p. ct.

Each of these shells is placed well near the center of the range of the dextral colony at large, in each of the individual characters; in its colorations also each is a typical representative of its association.

COLOR CHARACTERS

The formal diagnostic description of the species enumerates five color classes; this is a small number when the extent of the territory is considered, and much smaller than in the case of *P. dendroica*, which occupies an approximately equal area. The absolute and relative numbers in the several associations assigned to these color groups are given in table 7.

Unbanded shells with a general russet coloration are distinguished as **fusca** (plate 18, figs. 19-28). The apex is light. Fine transverse streaks of brown occur on the body-whorl, giving a very distinctive appearance. This color class is universally represented.

The class named **lyra** displays three revolving bands of deeper brown, curiously spaced (plate 18, figs. 29-35). The outer bands are symmetrically situated between suture and base, while the intermediate band is not exactly midway between them, in the median line, but is displaced toward the lower of the other two. This arrangement of three bands recurs in *P. mirabilis*.

A close relative of the preceding type is that called **asymmetrica**, where the two lower bands are confluent (plate 18, figs. 36-39). In some transitional shells, the **lyra** pattern is displayed on the smaller coils and it merges into the **asymmetrica** condition on the final whorl (plate 18, fig. 39). But such intermediates are few and usually the two color classes are quite distinct.

The color class called **zonata**, which at first sight might seem intimately related to the foregoing, is really very different (plate 18, figs. 40-43). Its broad zone of deeper brown does not include the upper (or right) band of the **lyra** series, although its lower border does correspond with the lower (or left) member of the three stripes which **lyra** possesses. Sometimes the zone is divided (plate 18, fig. 42), but it does not seem desirable to make a further class division, as such shells of the **zonata** class are so sparsely represented.

Finally, solid dark-brown shells occur, which are named **phæa** (plate 18, figs. 44-46). Two such individuals were found in middle Paraoro in 1923 and two in

Paparoa in 1909. They are evidently quite scarce, and presumably the factors responsible for their unusual condition are rarely combined in heredity.

While it will be more evident at a later juncture, it must be pointed out here that the whole color complex of *aurantia* is suggestively like that of *P. mirabilis* in several respects, indicating a real relationship, just as the peculiar qualities of the aperture and lip are much alike in the two species. The three color types of **fusca**, **lyra**, and **phæa** are almost identical in *aurantia* and *mirabilis*; and although the exact counterpart of **zonata** in the former is not found in the latter, a broad girdle of deep color is displayed in a considerable number of cases in *mirabilis*.

TABLE 7—*Partula aurantia. Census of the color classes*

Series	All	Dextral					Sinistral
		fusca	phæa	lyra	asymmetrica	zonata	lyra
Number of adults							
Paraoro middle, 1909	165	109	..	50	4	2	..
Paraoro middle, 1923	215	152	2	46	9	6	..
Paraoro south, 1923	181	116	..	55	...	9	1
Paparoa, 1909	270	55	2	140	68	4	1
Paparoa, 1919	105	12	..	68	25	..	..
Paparoa, 1923	357	5	..	250	99	3	..
Vaiare-Vaipohe, 1919	104	3	..	71	30	..	..
Vaiare-Vaipohe, 1923	24	3	..	11	10	..	..
Vaiare-Faamaariri, 1923	121	51	..	63	7	..	..
Vaiare-Faamaariri, 1924	82	30	..	40	12	..	..
Whole series	1624	536	4	794	264	24	2
Percentage of adult population							
Paraoro middle, 1909	.....	66.1	....	30.3	2.4	1.2	....
Paraoro middle, 1923	.....	70.7	0.9	21.4	4.2	2.8	....
Paraoro south, 1923	.....	64.2	....	30.3	.....	5.0	0.5
Paparoa, 1909	.....	20.4	0.7	51.8	25.2	1.5	0.4
Paparoa, 1919	.....	11.4	....	64.8	23.8	....	....
Paparoa, 1923	.....	1.4	....	70.0	27.8	0.8	....
Vaiare-Vaipohe, 1919	.....	2.9	....	68.3	28.8	....	....
Vaiare-Vaipohe, 1924	.....	12.5	....	45.8	41.7	....	....
Vaiare-Faamaariri, 1923	.....	42.1	....	52.1	5.8	....	....
Vaiare-Faamaariri, 1924	.....	36.6	....	48.8	14.6	....	....
Whole series	.....	33.00	0.25	48.89	16.26	1.48	0.12

All five color classes were found in only two of the ten series. The **phæa** shells, as already noted, are sporadic. All of the Paraoro series and two of the Paparoa collections comprised **zonata**, in small numbers. The other three color classes are practically ubiquitous, but their relative numbers are quite different. It appears that the **fusca** class is least abundant in Vaiare-Vaipohe and in the later series from Vaiare-Faamaariri, while it is about as numerous in Vaiare-Faamaariri as it is in Paraoro; these relations give additional support to the conclusion of an earlier paragraph, that somewhat independent lines of advance had been taken by *aurantia* in crossing the main divide from the inner areas to the Vaiare sector.

The variations in color composition observed in passing from one locality to another, and from one year to another in the same valley, give no indication of an environmental control or causation. It is unnecessary to argue this point.

When the statistical analysis proceeds to the comparison of the color classes, valley by valley and series by series (tables 45, 46), it does not appear that a given color class, as lyra for example, differs from an associated class in the same way in all colonies. Perhaps the clearest illustration of this point is provided by the phæa shells, even though they are few; they are much the smallest in the 1923 series from middle Paraoro but are exceptionally large in the Paparoa collection of 1909. Again, the zonata class is relatively small in the 1909 collection from middle Paraoro but comparatively large in the 1909 and 1923 associations of Paparoa. These facts mean that the hereditary distinctions of color are not closely correlated with qualities of structure, except in so far as the factor of immediate family relationship is operative.

EMBRYONIC MATERIAL

This species agrees with the majority of the genus in its reproductive rates (tables 49, 50). About 78 per cent proved to be gravid and contained approximately 3 embryonic items apiece. The rate for the whole series is 2.3 eggs and young; this is not so high as to account for the recent increase in numbers of the species and for the expansion of its area of occupation in proximate years. But the figures relate to animals taken during the less humid period of the year in all cases; how active they may be during the other months is not known.

The embryonic capsule is always opaque. Two cases only came to notice where "anachronisms" occurred in the order of the embryonic contents; in both of these an "egg" stood between two "young" snails. It is probable that these were really capsules without zygotes and not fertile eggs, pushed forward beyond the older items. A very rare condition was observed in one instance where two well-grown embryos were enclosed in a single capsular membrane.

Taking up the characters of the embryonic young and their significance, the matter of primary importance is spirality. All of the dextral adults with young bore similar offspring. The single fertile sinistral parent, taken in Paparoa in 1909, bore two young, *reversed like itself*; hence it transmitted its mutant character, like analogous cases of *mirabilis* and *mooreana* to be described later. While it would be unjustifiable to generalize from scanty data, we must recognize that this case presents at least two of the essential elements for the production of a new variety; the mutant condition has arisen, and it has continued in the next generation. If the novel young should live and breed *inter se*, and should transmit the new character in their turn, then the numbers of their descendants of like nature would progressively increase, establishing a new stock under the old conditions and among their unchanged associates.

The analysis of the distinctions of color encounters the same difficulties as in the case of *dendroica* and other species. Chief of these is the development of the definitive class characters only after early embryonic life. The very young embryonic shells are usually yellowish or light yellowish brown in color, very rarely

brown. Some of the young, just before birth, develop the transverse brown streaks which are so characteristic of most of the adult shells. In a surprisingly small number of instances (table 51) the embryonic shell is broadly banded. Four young out of ten produced by **zonata** are thus marked. Considering the large relative numbers of **lyra** shells, the proportion of similarly banded offspring is very small indeed.

If the banded color classes are combined, the number of such adults in the whole population is 1084, or 66.7 per cent, leaving 33.2 per cent of unfasciated **fusca** and **phæa**. The total number of unbanded young is 1432, or 98 per cent, and only 2 per cent are fasciated. Obviously most of the plain young are destined to develop one or another form of banding on the later-added whorls.

When the records were first made, the offspring were listed as "light," "faint brown," and "brown"; but an attempt to correlate such embryonic distinctions with qualities of their parents would not be profitable in view of the many uncertainties in the problem. The question of free intercrossing on the part of the several color types is one that demands actual genetic experiments for its determination.

SUMMARY AND CONCLUSION

Partula aurantia is a recently discovered species which now occupies a compact territory comprising four valleys of the northeastern part of Moorea. While there is no earlier basis for comparison in the works of Garrett, yet the observations of the present research make it possible to record something of the history of the species during recent years. The species was more closely confined in former times, and its center was probably in northern Paparoa. The detailed records of numerical abundance, together with the topographical, ecological and geographical data, show that *aurantia* has spread northward into Paraoro but not beyond into Farehotu, and it has also migrated across the divide from Paparoa into Vaiare-Vaipohe and from upper Paraoro into Vaiare-Faamaariri. Within my own experience, since 1909 *aurantia* has descended in Paparoa Valley to the lowest levels, namely, to the very borders of the main stream which drains the Paopao basin.

While the prevailing mode of coil is dextral, two reversed mutants have been found, and one of them bore young which perpetuated the sinistral character. Instances of this kind are excessively important because they are unquestionably contemporaneous and because they show how new types may arise and establish themselves in the original ecological setting.

The several representative collections vary from place to place in morphological respects and in colonial color composition; no relation can be discovered between surrounding circumstances and such colonial qualities.

In its entirety, *P. aurantia* stands about midway between *P. suturalis* and *P. mirabilis*, so far as general structure is concerned. In the characters of the aperture and in some of the class distinctions of coloration, *aurantia* is much more nearly related to the latter. Following the orthodox method of interpreting organic likenesses, we may therefore conclude that in remote times there was a common ancestral stock from which *aurantia* and *mirabilis* have descended, and undoubt-

edly this stock was more widely distributed in the eastern half of Moorea. A period of contraction followed, the original area became divided, and in consequence the colonies of the extreme northeast became separated from those situated nearer the center of the island. Each of these subdivisions then developed its distinctive specific features, the former to become *aurantia* and the latter as *mirabilis*. In most recent decades, each of these has strengthened in vitality and increased in numbers, with the result that each has occupied new and wider territory.

The latest episodes of this history are quite different from what is rewritten in the cases of *tohiveana*, *olympia* and *dendroica*, which give no evidence of geographical expansion and biological differentiation within most recent years.

CHAPTER IX

PARTULA MIRABILIS Crampton

GENERAL CONSIDERATIONS

While each species of Moorea presents features of peculiar interest, no other exhibits the remarkable combination of significant qualities of *P. mirabilis*, which indeed has received its name on this account. It is very well defined and sharply distinguished from all others of its island. It now dwells in considerable profusion in eleven valleys that are more or less contiguous, and yet its existence was entirely unsuspected until the present research brought it to light. The first specimens were discovered in 1909 in Maramu Valley—a member of the inner or crater series of localities—and it was subsequently taken not only in other inner valleys but also in Vaianai and Oio Valleys of the outer crescent, and in the Matapoopoo region of the Rotui sector. In the last-named area it has come to preponderate over its associates, *P. tæniata* and *P. dendroica*.

The whole territory occupied by *mirabilis* is traversed by the long-used paths from Paopao to Opunohu, and from Opunohu across to Vaianai. Garrett must have used the former at least. Yet he did not find this species if we judge from the records and from the collections sent out by that energetic collector. It must have existed somewhere in his time, for its age is demonstrated by its wide separation from other species of its island, as well as by its diversification in coloration. It seems almost incredible that in a comparatively brief time it could have spread so widely from its original contracted headquarters, yet the conclusion that it has done so, mainly if not entirely since Garrett's time, can not be escaped. If the same history were not demonstrated in several other species of Moorea it might be preferable to suppose that Garrett did not explore the central part of Moorea as completely as he did others. But Garrett could not have described the other species of the valleys now inhabited by *mirabilis* without visiting these areas; the associates now correspond so closely with what Garrett did record that no doubt exists as to the absence then of what is now in some instances the dominant species.

On account of its novelty and special features of interest, *P. mirabilis* has been earlier described together with other new species.[1] The original description is here given without references to illustrations and without the figures for its structural characters, as the last are more fully recorded in the present chapter.

"Shell dextral (reversed in rare mutations); ovate-conic to elongate-conic, openly or compressly perforate. Whorls 5, slightly convex, the body-whorl flattened toward the lip; suture of the last whorl impressed. The surface is sculptured throughout, but the lines are fewer on the larger whorls, which are shining and generally smooth except in decorticated specimens.

"Aperture narrowed, elongated, almost oblong in general outline. Lip sharply beveled, thin and smooth. A thin, roughened callus spreads between the insertions of the lip. Parietal tooth present in almost all instances, but it is seldom prominent.

[1]Nautilus, 1924.

"Colors: (*a*) corneous-fleshy, apex pale brown; (*b*) pale brown, with deeper brown transverse strigations; (*c*) corneous brown, with darker brown, ruddy, or rose-brown spire; (*d*) deep chocolate brown or seal brown, the spire usually lighter; (*e*) light brown, with three revolving bands of deeper brown color, and usually with sutural and basal clouding; (*f*) encircled by a broad zone of deep brown color, which is separated from the brown sutural and basal areas by narrow corneous lines, often with an asymmetrical revolving corneous line through the median line itself; (*g*) deep seal brown in general, with a revolving corneous zone toward the base and just within the suture of the upper whorls; (*h*) brown, save for a median revolving area which is corneous. The lip is white in the lighter colored classes, and stained with brown or purplish brown in the darker divisions.

"Embryonic young are either brown of various shades, or they are clearly girdled by a central zone of darker color; the latter condition develops into the several forms of final adult fasciation. The egg-capsule is opaque.

"Habitat: Moorea, Society Islands: several subordinate localities within the central crater valley of Opunohu, and in some adjacent areas."

The territory occupied by *mirabilis* is relatively greater than in the case of any of the preceding species, and in some of the subordinate localities its numbers are very large; hence there is a satisfactory abundance of material for analysis. The adults amount to 4631, and all but 12 of these are dextral. Partly grown individuals number 438, only one of which is reversed. There were in all 4218 embryonic young sufficiently advanced to display the definitive coil and some other characters; of these 27 were sinistral. During the whole period of the research the species was found in eleven localities, and the total number of series taken in the different years amounts to 20. It is clear that an adequate description of the material must be more extensive than heretofore, in order that the significance of the facts may be duly brought out and formulated.

AREAL RELATIONS

The area now occupied by *mirabilis* needs no more detailed description than that given in other sections of this volume. The general outlay is covered by the maps and diagrams of Chapters I and II, while special portions have been more fully described, such as Matapoopoo Valley in the section on *P. dendroica*, and Fareaito Valley with its environs in the chapter on *P. tohiveana*. The relation between Vaianai Valley and Maramu Valley is very important in the present connection, as it is also in the case of *P. mooreana*; this topic will be discussed in the chapter on the latter species.

Certain obvious features of the general distribution of *mirabilis* make it plain that the species must have spread recently from a smaller area of occupancy. Whereas 5 per cent of the Vaianai series of 1923 (*cf.* table 1) were *mirabilis*, none were found in that valley in prior years; it is true that the last year's collections were taken mainly in the higher part of Vaianai, but *mirabilis* was found in the middle level where it had not been seen when the substantial earlier lots were collected. However, the fact that it was more abundant in the higher valley near the pass, beyond which the species exists in abundance, is itself proof that *mirabilis* had only recently migrated across the ridge. The single specimen from Oio, taken in 1919, proves that a tongue of penetration had diverged from the main stream

into Vaianai almost at the pass itself, to push farther downward to the west of the ridge which separates Vaianai and Oio.

The next and most prominent feature of distribution is the abundance of *mirabilis* in Matapoopoo Valley, in the sector dominated by Mount Rotui. Here there is no question that its numbers have rapidly increased recently, for even when all allowances are made for local variations in numerical abundance, the high percentages of 83 and 97 for the eastern and western series of 1923 are in marked contrast with 33 per cent and 24 per cent for 1909 and 1919, respectively. The associates in the way of *P. tæniata* and *P. dendroica* have not markedly diminished in actual numbers in the interval; the differences indicate a prodigious increase of *mirabilis*. Again, the fact that *mirabilis* occurs in the Rotui sector in Matapoopoo Valley proves its late incursion into this territory. The ecological conditions at the contacts of Matapoopoo with Vaihiaiia on the east and Tepatu on the west are such as to check the tides of migration to some extent, it is true, but they can not be regarded as insuperable obstacles when *tæniata* and *dendroica* have overpassed them.

Returning to the main area inhabited by this species, the conclusion is inevitable that the outer fringes have not been held for a long time. The limiting valley of Ririofau to the east is directly connected with Poua and beyond, where *suturalis* and *tæniata* range in unbroken continuity. The present species has spread westward as far as Faataofe; but there is no reason, except its recent incursion into Faataofe, why it should not be found farther on. It is evident from the census table that *P. mooreana*, likewise a recent entrant into this area, has migrated not only to Faataofe but also beyond to Roroie, thus proving the absence of a real barrier between Faataofe and Fanautaata.

For various reasons, it should be noted here that the relative census figures should not be taken too literally. The Maramu series of 1909 came from the lower valley where *suturalis* and *mooreana* are far less abundant than above; the Maramu series of 1919, 1923 and 1924 give better indices of the abundance of *mirabilis*. The low figures for this species in Fareaito are due to a greater interest in the novel species, *P. tohiveana*; the higher figures for Faataofe are the result of a special interest in the *mirabilis* of the area where sinistral mutants are more abundant than in other places. Making all qualifications, it appears that *mirabilis* is most abundant in the Tefeo-Irua series of localities which are approximately central in the whole territory of occupation; this territory may therefore be regarded as the original headquarters before the species began to increase in number and to expand its range, thus paralleling *P. aurantia* and *P. mooreana* in its history.

The Matapoopoo colonies present an interesting problem in this connection. The low forests of the eastern Oponohu basin are sparse and interrupted for the most part, but the degree of continuity is greatest between Irua and Matapoopoo. The question is whether *mirabilis* has come across from Irua in the course of recent territorial expansion, or whether in former times relic colonies existed in Matapoopoo and in the Tefeo-Irua region. In the latter case, such relics must have become separated as the result of a disappearance elsewhere of what must have been a

wide-spread series of associations, just as the *olympia* and *tohiveana* colonies of today are surviving remnants. The extraordinary abundance of *mirabilis* in Matapoopoo seems to support the latter interpretation. But the close structural resemblance between the Matapoopoo series and the central associations, as well as the evidences that Matapoopoo has been *recently* occupied, would support the view that there has been only one primary center of dispersion. Had a separation existed earlier, the outlying colonies would have possessed at the least the opportunity to depart in morphological respects in their own ways, and presumably they would have done so.

STRUCTURAL CHARACTERS

In the category of structural qualities (plate 18, figs. 49-53; plate 19, figs. 1-37), the direction of the coil is of first importance. The species is generally dextral, but sinistral mutants have been found in two localities. The first of these is Faataofe Valley, which lies at the western extreme of the range of the species in the inner crescent. Here three reversed adults were taken in 1923 and seven in 1924 (plate 19, figs. 14, 15, 25)—approximately 2 per cent of the adult series of *mirabilis*. In Maramu Valley two sinistral adults came to hand in 1909 (plate 19, fig. 3) and one unmistakably similar adolescent snail in 1924. It is a strange coincidence that the associated sinistral *P. mooreana* has produced *dextral* mutants in the same two valleys.

The immediate mode of origin of these unusual individuals is a question of much interest; they may represent an independent sinistral stock with very sparse numbers, or they may be the products of sporadic and contemporaneous mutation from dextral parents. The evidence at hand shows that reversed individuals arise in both ways. The dextral adults of the Faataofe collections bore dextral young in the great majority of cases, but in three instances *a dextral parent bore a sinistral offspring.* The reversed adults produced sinistral young in two instances, while dextral young were found in sinistral parents in four other instances. One very important case occurred where a *reversed adult bore one dextral and one sinistral offspring at the same time;* this instance is similar to what was found very rarely in *P. suturalis* from Vaiare-Faamaariri Valley[1] and it adds its support to the views of Boycott and Diver regarding chromosomal control of the inheritance of coil.

The Maramu series of 1909 comprised three dextral adults in which sinistral embryonic young were found—single in two cases and two in the third case. A solitary gravid sinistral parent bore one young snail of similar nature. The sole sinistral adolescent found in 1924 does not constitute an item of evidence, for it may have originated in either way; but the absence of any sinistral adults would suggest its mutation from a dextral parent.

Taking up the structural characters of the several colonies as they are defined statistically, many interesting results come to light when the figures are analyzed in detail (tables 52-54). The characters of color are also significant, but they must be considered separately to avoid confusion.

[1]H. E. Crampton, *Coincident production of dextral and sinistral young in the land-gasteropod Partula*, Science, vol. LIX, No. 1538, 1924.

The shells of the *mirabilis* association in Vaianai are collectively much smaller than those of Maramu Valley, from which the outer migrants must have come, and they are more slender in the proportions of the whole shell and of the aperture; they agree in the final proportionate measure. The first-comers from across the divide may have chanced to be smaller, or their descendants may have diverged from the average condition of the earlier stock. In the latter case, however, we can not attribute the colonial divergence to external factors *per se*, because the associated species do not exhibit corresponding differences when similar comparisons are made.

The extreme western colonies of Faataofe are also much smaller in stature than the longer-established associations of Maramu. Passing eastward through the main range of *mirabilis* there is a progressive diminution in length as far as Tefeo East, an increase in the step to Fareaito, a decrease again to Irua, and an increase in the final stage to Ririofau Valley. When all of the characters are taken into account, it is evident that each association presents its own combination of qualities in correspondence with its substantial isolation.

The Matapoopoo series are obviously near structural relatives of the Irua colonies, which is natural in view of the ecological and geographical circumstances. While the former differ little in the general make-up of the shell, the aperture is peculiar in all respects, and the proportion of the aperture to the shell is also aberrant.

Just as the several colonies differ from one valley to another, so also the subordinate components present contrasts when they are delimited and compared. For example, the Maramu collections of 1909 and 1919 were taken in the lower part of the valley, while those of the later years were secured higher up. The former are relatively larger (tables 52, 53). In Tefeo proper (tables 52, 53) the relations are similar, but in Tefeo East they are reversed, although the differences are not very large. Again, in Fareaito where the 1924 series was secured from a slightly higher level than that of 1923, small differences are disclosed. Without laboring the argument, it seems just to conclude that when such differences are observed, their factors belong to the congenital category and are not environmental.

The summary figures for the entire species as given in table 52 provide the basis for a comparison of *mirabilis* with other species of Moorea and elsewhere. While any one of the characters might be duplicated in some other species, their combination is distinctive, like the collective qualities of coloration.

The statistical characters of the sinistral shells are noted in the detailed tables relating to the color classes (tables 56, 57). At this point the note may be made that their several conditions fall well within the ranges of the qualities displayed by their dextral associates of the respective series.

Relatively few shells lack the pillar tooth (table 54) and very few show a high development of this structure. The average degree of its manifestation is quite uniform throughout the whole range of the species, although it is somewhat lower with consistency in the series from the Matapoopoo region.

Turning finally to the extrinsic relations of *mirabilis* and to the questoin of its affinities with some other species, the result of a close morphological comparison is that *P. aurantia* is the only one giving indications of a proximate common parentage. The critical features are those of the aperture and the lip. In both species the aperture is upright, small and narrow. The lip in both is characteristically beveled and thin. In their other qualities each has diverged in its own way from the common ancestral condition, in structural respects as well as in coloration.

COLOR CHARACTERS

The several communities of *mirabilis* present very varied aspects of coloration when they are compared as entireties. There are three kinds of differences. A given association may be unique as regards the combination of color types that are present, or in the existence in that colony only of a peculiar color class not found elsewhere. Or it may be that two colonies will be made up of similar components but their whole color complexions will be markedly different on account of diverse proportions of the color types. Finally more subtle variations among the colonies are found in the quantitative differences displayed by the color components themselves.

Seven color classes are recognized in the present description, and their census is given in table 8. Three of these are devoid of fasciation, while four others are distinguished by longitudinal, revolving bands of one pattern or another. It must not be assumed that this classification is ultimate, because it is found that what is properly called a single color class varies in lesser details from one place to another.

Disregarding the matter of relative frequency, we may begin with the unbanded groups. The first includes light brown or light corneous-brown shells with a darker apical region, hence called **apex** (plate 18, figs. 49-53; plate 19, figs. 1-3). This type occurs universally throughout the inner crescent of valleys, except Mouaroa. Very rarely it is marked with fine, darker transverse streaks. In Matapoopoo, however, almost all of the class are distinctly strigated (plate 18, fig. 53; plate 19, figs. 1, 2); yet as a mark of their affinities with the plainer shells elsewhere, they possess the apex of dark color. The Matapoopoo shells might well be placed in a separate color order, to be named **apex strigata**, but the nomenclature is secondary to their recognition.

The next type is called **mitella** because it closely simulates a class of *P. gibba* from the Mariana Islands so designated. Here the shells are very like those of **apex** in ground-color (plate 19, figs. 4-8) and likewise they vary from lighter to darker shades. The distinctive feature is the rosy color of the spire, which in rare instances spreads downward over part or nearly all of the body-whorl (plate 19, figs. 5, 6). In decorticated specimens (plate 19, fig. 7) the rosy or rose-brown color of the spire stands out in sharper contrast. The complete absence of **mitella** from the colonies of the Matapoopoo region is noteworthy; its non-appearance in the Vaianai series is to be expected in view of its sparse representation in Maramu, whence Vaianai was populated.

The third class is very much more abundant, especially in the western part of the inner circle of valleys. It is called **phæa** (plate 19, figs. 9-15) on account of the

deep-brown color of the whole shell. Many individuals of this class found in Maramu display a lighter color on the spire (plate 19, fig. 12). Most of the sinistral specimens from Faataofe belonged to this class (plate 19, figs. 14, 15) which is by far the most abundant in that locality.

TABLE 8—*Partula mirabilis. Census of the color classes*

Series	Year	Total	Dextral							Sinistral			
			apex	mitella	phæa	lyra	zonata	sub-zonata	bisecta	apex	phæa	lyra	zonata
Number of adults													
Oio	1919	1	...	...	1	...	...	...	..	..	..	..	..
Vaianai	1923	74	...	...	52	4	18	...	..	..	..	..	..
Faataofe	1923	145	8	...	121	7	...	...	6	..	3	..	..
Faataofe	1924	403	22	14	298	54	...	...	8	..	6	1	..
Mouaroa	1924	32	...	4	27	1	...	...	..	..	..	..	..
Maramu	1909	325	122	26	102	7	8	53	..	1	1	..	..
Maramu	1919	38	14	...	12	...	4	8	..	..	..	..	..
Maramu	1923	51	3	...	21	1	25	...	..	..	..	..	..
Maramu	1924	214	26	10	80	2	96	...	..	..	..	..	(a)
Tefeo	1923	481	163	18	182	19	45	54	..	..	..	..	..
Tefeo east	1923	843	334	142	161	150	33	23	..	..	..	..	..
Fareaito	1923	131	1	30	19	61	19	...	..	..	..	..	..
Fareaito	1924	296	8	57	11	193	25	1	..	..	..	..	..
Irua west	1919	57	1	5	17	27	7	...	..	..	..	..	..
Irua east	1919	287	71	31	58	81	25	21	..	..	..	..	..
Irua south	1923	236	76	65	19	74	2	...	..	..	..	..	..
Ririofau	1924	23	3	11	4	5	...	...	..	..	..	..	..
Matapoopoo	1909	69	4	...	...	63	2	...	..	..	..	..	..
Matapoopoo	1919	215	9	...	...	202	4	...	..	..	..	..	..
Matapoopoo west	1923	580	34	...	5	512	15	14	..	..	..	..	..
Matapoopoo east	1923	131	20	...	8	93	...	10	..	..	..	..	..
All	....	4,632	920	413	1,198	1,557	328	190	14	1	10	1	(a)
Percentage of adult population													
Oio	1919	.....	.....	.....	(100)	.....	.....	.....	....	....	....	....	..
Vaianai	1923	.....	.....	.....	70.3	5.4	24.3	.....	....	....	....	....	..
Faataofe	1923	.....	5.5	.....	83.5	4.8	.....	.....	4.1	....	2.1	....	..
Faala	1924	.....	5.5	3.5	73.9	13.3	.....	.....	2.0	....	1.5	0.2	..
Mouaroa	1924	.....	.....	12.5	84.4	3.1	.....	....	....	....	....	....	..
Maramu	1909	.....	37.5	8.0	31.4	2.2	2.5	17.5	....	0.3	0.3	....	..
Maramu	1919	.....	36.8	.....	31.6	.....	10.6	21.0	....	....	....	....	..
Maramu	1923	.....	5.9	.....	41.2	3.9	49.0	.....	....	....	....	....	..
Maramu	1924	.....	12.1	4.7	37.4	0.9	44.9	.....	....	....	....	....	..
Tefeo	1923	.....	33.9	3.7	37.8	3.9	9.4	11.2	....	....	....	....	..
Tefeo east	1923	.....	39.6	16.8	19.1	17.8	3.8	2.7	....	....	....	....	..
Fareaito	1923	.....	1.5	22.9	14.5	46.6	14.5	.....	....	....	....	....	..
Irua east	1924	.....	2.7	19.2	3.7	65.2	8.4	0.7	....	....	....	....	..
Fareaito	1919	.....	1.7	8.8	29.8	47.4	12.3	.....	....	....	....	....	..
Irua west	1919	.....	24.7	10.8	20.2	28.2	8.7	7.3	....	....	..	....	..
Irua south	1923	.....	32.2	27.5	8.0	31.4	0.8	. ....	....	....	....	....	..
Ririoafau	1924	.....	13.0	47.8	17.4	21.7	.....	.....	....	....	....	....	..
Matapoopoo	1909	.....	5.8	.....	.....	91.3	2.9	.....	....	....	....	....	..
Matapoopoo	1919	.....	4.2	.....	.....	93.9	1.9	.....	....	....	....	....	..
Matapoopoo west	1923	.....	5.8	.....	0.8	88.3	2.6	2.4	....	....	....	....	..
Matapoopoo east	1923	.....	15.3	.....	6.1	71.0	.....	7.6	....	....	....	....	..
All	....	.....	19.87	8.92	25.85	33.62	7.08	4.10	0.30	0.02	0.22	0.02	..

[a]One adolescent found.

Passing to the banded shells, the most characteristic color type is that which possesses three revolving bands of brown on the larger whorls; it is called **lyra** (plate 19, figs. 16-25) and is somewhat similar to the class of *P. aurantia* given the same name. This class is extraordinarily abundant in the Matapoopoo region. The bands do not appear on the smallest whorls, which are variously tinted with brown, but they are formed by differentiation of an early uniform color. Variants of the **lyra** type may have the middle band almost if not quite evanescent (plate 19, figs. 19, 20) or they may add sutural and basal bands to the standard series of three (plate 19, figs. 21-23). Two shells of Faataofe lack the lowermost band and almost justify the establishment of a class to contain them, to be named **bilineata** (plate 19, fig. 24); for the sake of simplicity, they may still be regarded as **lyra**. The shells of figures 16 to 18, plate 19, represent the greater majority of **lyra**; although several unusual forms of the pattern are illustrated, the latter occur in small numbers. One of the reversed specimens from Faataofe belonged to this class (plate 19, fig. 25).

While the class named **zonata** (plate 19, figs. 26-30) may seem to be closely related to **lyra**, this is not the case. Here the shell is very dark brown with two revolving areas of light horny brown which border a broad median zone. The limits of this girdle do not correspond exactly with the lateral bands of the three in **lyra**. Rare variants occur with a thin line of lighter color traversing the broad zone (plate 19, fig. 29). The shells of the illustrations show several of the numerous variations in size and shape. The solitary sinistral adolescent taken in Maramu in 1924 belonged to this class, which is distinctly dominant in that region.

The next fasciated type is a close relative of the foregoing, as the name **subzonata** indicates (plate 19, figs. 31-33). It accompanies the former in nearly all of the localities from Maramu to Irua, and appears also in some of the Matapoopoo series. It possesses only the lower of the lighter longitudinal areas which **zonata** displays.

Finally there is a very distinctive class that was found in Faataofe Valley only, and in small numbers. This is **bisecta** (plate 19, figs. 34-37). Again the general color is dark brown as in **phæa**, **zonata** and **subzonata**, but it is divided in the median line by a narrow light stripe. The same pattern recurs in *P. mooreana* and *P. suturalis*.

Having distinguished the principal color classes, we must now survey the entire area of occupation in order to note more particularly the colonial differences in color composition, and also to carry the analysis to the last stage where the color classes themselves are compared on the basis of structural characters defined in statistical terms.

Beginning with the few representatives in valleys of the outer circle, Vaianai and Oio (table 55), the main point is that the classes present are **phæa**, **zonata** and **lyra**, in order of numerical abundance. The first named is the most frequent in Maramu Valley, whence Vaianai and Oio have been populated. The absence of **apex** and of **subzonata** means that the genetic factors for these kinds were not carried by the first migrants across the old crater wall. The statistics for the

Vaianai classes are self-sufficient, but one notable point is that the few lyra depart distinctly from their associates in such ways as to suggest that they represent a compact family group within the colony. The single specimen from Oio is significant only as a positive proof that *mirabilis* had reached that area by 1919.

Passing to the main series of colonies in the inner circle of valleys, we begin with the most westward, although these are of latest establishment. The figures are given in table 56. The two Faataofe series agree closely as regards the qualities of the dominant phæa class, but the accompanying classes do not correspond in the same way. A few mitella were found in 1924 which were collectively large in all dimensions and relatively stout as well; but none were taken in 1923. The few lyra of both years agree well in absolute dimensions, but diverge in relative measures. The bisecta classes, found only in this area, differ in absolute dimensions but agree in their proportions. These facts mean that the color classes other than phæa are composed of only a few family groups, somewhat sporadic in their occurrence within the whole area of Faataofe Valley.

The sinistral individuals found in Faataofe are exceedingly important, even though few. In both series they are collectively larger than their dextral relatives, and in all of their characters the differences are within the range of probable error. Here the evidences are clearer that the snails in question constitute a definite family group produced by mutation from dextral antecedents and holding a place at least from one year to another and presumably longer, as the embryonic young indicate (*q.v.*).

The Mouaroa colony is in a sense an outlier of the Maramu association. It occupies a peninsula of forest reaching downward from the heights along which the migrants passed from upper Maramu to Faataofe. The phæa class is dominant, which is to be expected. Only mitella and lyra are positively known to be also present; the absence of other classes emphasizes the separation of the area in question from Maramu and Faataofe on either side.

Four series from Maramu Valley are available for analysis. The collections taken in 1909 and 1919 represent the species in the relatively lower levels of the valley; the later collections were secured at higher levels. In general (table 57), the snails of the lower ground are larger than those living above the 500-foot barometric level. The correspondences are fairly close in the proportionate measures. Such differences as appear when the 1909 series is compared with that of 1919, as for example in the width and in the proportions of the whole shell, are presumably due to the small numbers of the latter group and are less likely to mean that real changes had come about in the interval. The sinistral mutants of 1909 differ widely from their dextral associates, and they are enough alike to suggest their close common parentage. The only reversed example of other years was an adolescent, which might have been an independent mutant or a member of a small genetic group whose other members escaped detection. The color classes of the two earlier years are remarkably consistent throughout in their structural characters, but those of the later years do not exhibit similar agreements. It is note-

worthy that apex is more abundant in the lower portions of Maramu, while zonata dominates at higher levels. Both lyra and mitella of 1924 are definitely larger than their associates, and they resemble the corresponding classes below them in such ways as to suggest an independent downward migration of snails with the distinctive forms of coloration, rather than free intermixture with the other classes of their subregion.

The Tefeo area is abundantly inhabitated by *mirabilis* and the statistical data are reliably full (table 58). Tefeo East is very close to Tefeo in the narrower sense, yet marked differences in colonial make-up appear in the census (table 8). The apex class is very infrequent in lower Tefeo up to the 450-foot level, but very abundant from there up to 1000 feet; in Tefeo East it is the dominant class both below and above the height of 550 feet. In the upper part of Tefeo East mitella and lyra are richly represented, but elsewhere their numbers are few. The two areas in question are in close proximity and their ecological conditions are practically identical; nowhere else are the facts so clearly indicative of the internal causation of the qualities manifested by the snails. In statistical respects, the animals of the lower division of Tefeo are relatively larger, but in Tefeo East the reverse relation is shown. The color classes do not differ in the same ways in the two contiguous regions, but are entirely independent. Many other conclusions might be drawn from the statistical details, all of which would confirm the view that external conditions are not factorial with reference to the qualities of structure or of color.

In Fareaito Valley (table 59) lyra dominates over phæa, and mitella is well represented, as in Tefeo East. The shells are distinctly larger than those of the colonies to the west. The collection of 1924 was taken a little higher up than that of 1923, and it differs, if only slightly, in correspondence. The lyra class is somewhat smaller than the average in both series, and the mitella class is larger than the average in the two series. The other types are not particularly significant.

Although the three subordinate areas of the Irua region are not far apart, their colonies are markedly different in color composition (table 60). The lyra class prevails in the west and in the east, phæa varies greatly, while apex is even more uneven in its distribution. The mitella class is almost the reciprocal of apex. The small lot from Ririofau Valley is interesting mainly because it lies at the eastern extreme of the whole range. The statistics relating to this colony require no special comment.

The Matapoopoo region lies apart, with the low ground of Opunohu between it and the preceding array of localities. Here *mirabilis* is the dominant species, but despite its great numbers it has not yet spread into the habitable areas on the two sides of Matapoopoo. The several series (table 61) are characterized by the dominance of the lyra class, which sets the structural standards. It is noteworthy that the apex shells are almost all distinctly strigated in this area to degrees that are not equalled anywhere else. Representatives of some other classes are rare and sporadic, while mitella does not appear at all. Considerable structural variation occurs in ways that are evident from the figures (table 61).

EMBRYONIC MATERIAL

The records of fecundity in *mirabilis* are satisfactorily full (tables 62, 63). They show that the species agrees closely with others of its island in practically every respect. A little less than 90 per cent proved to be gravid when they were collected, in all cases during the less moist and more temperate time of the year. What the rates might be during the somewhat contrasted seasons may only be conjectured. About two embryonic items were borne by each gravid adult. The Matapoopoo series exhibited lower rates of productivity in the earlier years of investigation, which is somewhat surprising in view of the great increase in numbers over subsequent years.

Only four instances were found where an egg had not been fertilized, thus presenting an apparent "anachronism" in the order of the embryonic contents. Two such cases appeared in the southern division of Irua, one in eastern Irua and one in the 1919 series from Matapoopoo. This number is very small when the total array of records is considered.

The embryonic snails with definite shells provide reliable data for the problem of the inheritance of spirality. Only in Faataofe and Maramu were sinistral snails of this species found at all; everywhere else dextral parents bore dextral young. No less than three dextral adults in each of the localities named were found to contain sinistral young. Two sinistral adults from Faataofe and one from Maramu bore their own kind of offspring, while in four instances a reversed parent bore dextral young which had obviously reverted to the standard mode of coil. One sinistral adult from Faataofe contained *one sinistral young and one dextral young*—a case that has been duly noticed in an earlier section of this chapter. Combining the figures for the two series from Faataofe, dextral adults produced 490 similar young and 4 sinistral offspring; while sinistral adults produced 5 dextral and 4 reversed young. The proportions of the two kinds are thus held stable by the reciprocal contributions from the two parental groups; but the left-handed individuals are few, and two or three additional items would materially affect the result.

Passing to the inheritance of the distinctions in color (table 64), certain definite conclusions are established, although the material falls far short of the ideal. Only in exceptional instances, varying in proportion from colony to colony, do the final patterns appear on the earliest formed whorls, which are generally dark and uniform in color. As a rule, therefore, a given embryo can not be definitely assigned to a particular color class. The later added whorls may display the **apex**, **mitella** or **phæa** characters, if unbanded; while resolution of the original uniform color may take place in various ways to give one or another of the fasciated patterns.

The cases where the characteristic pattern is precociously developed make it certain that the several color classes can interbreed; at least, adults of one type do produce young that belong unmistakably to another color class. In the Vaianai series of 1923, 2 out of 33 young borne by plain parents were **zonata**. In the Faataofe series of 1924, 2 of 53 young contained in **lyra** were broadly zonate, leaving it uncertain, it is true, whether they would remain so or would further resolve the girdle

of color into the lyra pattern. It will be recalled that the lyra and zonata types are not as closely related as they would seem at first sight. In the 1924 collection from Maramu, 3 out of 91 young from phæa adults were zonata. In the 1923 lot from Tefeo, 6 of 31 embryos from subzonata were certainly zonata, while 2 of 9 embryos from zonata parents were unquestionably subzonata; obviously these classes interbreed. One out of 111 young from the abundant apex adults of Irua, taken in 1923, was a true zonata.

The Matapoopoo associations are particularly valuable because many more of their embryos develop their distinctive patterns precociously, as shown by table 64. Only a few embryonic shells gain the definitive lyra pattern before birth; most of the young of lyra parents are still zonate when they emerge to the outer world. Many of the plain young are clearly destined to develop fasciation later, and they stand at the opposite extreme from the first-mentioned individuals. The general result, as already stated, is that the color classes do not breed true invariably, but contribute young to other categories than the parental; the conclusion that free intercrossing takes place seems to be fully established.

SUMMARY AND CONCLUSION

Brought to light only with the present investigation, *Partula mirabilis* does not appear in the older records, and hence no direct comparison of its later conditions can be made with an earlier state of affairs. The present area of occupation includes a consecutive series of valleys in the inner circle, a small sector of the outer circle, and one valley only of the Rotui sector. Portions of this area are traversed by long-used paths which must have been employed by Garrett in his journeys; the fact that he failed to find *mirabilis* is one indication of many that the species occupied more restricted territory in his time. Like some other species of its island, *mirabilis* has increased in numbers and has spread into new areas during recent years; the observed increase in Matapoopoo Valley, the manifest relations of the Vaianai association, and the conditions at the extremes of the inhabited series of valleys are important considerations in this connection.

The associations vary from valley to valley in the collective qualities of the shells, although the range of variation is not very wide in any character. The full statistical analysis is valuable in showing the same kind of areal variation as in other species. In each of two separated areas, the colony is distinguished by the presence of sinistral mutants, obviously parallel and independent in their origin from dextral progenitors.

The color composition of *P. mirabilis*, like its structural make-up, is markedly different from that of any other species, although some of the color types have counterparts elsewhere. Their combination, however, is not duplicated. When the several associations are compared, they prove to vary in three ways, always without any discoverable relation to external circumstances. Differences in the kinds of color classes present express one mode of variation, while differences in the proportions of the color types actually present constitute a second category. Finally, the quantitative characters of the color classes exhibit different relations,

even in neighboring valleys or in different subdivisions of one and the same primary area.

The reality of contemporaneous mutation is attested most clearly by the sporadic sinistral components in Maramu and Faataofe. Such reversed adults resemble some of their dextral associates so closely as to justify the inference that they must have been produced by right-handed antecedents very recently. But direct and conclusive evidence is provided by the sinistral young actually found inside of dextral parents. Some of the young of the reversed individuals revert to the former mode of coil, but others repeat the changed condition; thus complete proof is given that a new kind can originate and can multiply itself without spatial isolation from the parental stock. The existence, in Faataofe Valley alone, of a peculiar color type, **bisecta**, may also be taken as evidence of local mutation and the establishment of a new variant in the midst of an older stock; but the proof is not so direct as in the case of the mutations in spirality.

Casting back to the earlier history of *P. mirabilis*, the problem of its extrinsic affinities arises. There is no question regarding the full standing of *P. mirabilis* as a species. The only other species with which it exhibits any affinities is *P. aurantia* whose territory is separated from that of *mirabilis* by a gap of several miles. The characters of the aperture especially signify a real relationship of the two species in question. Reconstructing the prior history from the available pertinent facts, the common ancestral stock must have ranged over considerable territory of Moorea, with local variations such as every wide-spread species now shows. Whatever the reasons may have been, the continuity of this range became interrupted by the disappearance of whole series of associations, leaving two diverse relics in the Paparoa area and in the forests between Irua and Tefeo. The former gave rise to *P. aurantia* which remained somewhat confined to its region of origin until recent times. From the latter *P. mirabilis* took its form, and it also has recently increased in vigor, spread more widely, and differentiated in various ways in the several valleys of older and newer occupation.

CHAPTER X

PARTULA MOOREANA Hartman

GENERAL CONSIDERATIONS

With this species we encounter one of the long-established forms, and that one whose nature and record in the literature are simplest. It is exceptionally well demarcated from other Moorean species with wide distribution, such as *P. tæniata* and *P. suturalis*, especially in its general sinistral nature; and as the case stood prior to my own studies, it was the only known reversed species in the entire area of the Society Islands, although sinistral varieties of *P. otaheitana* and *P. nodosa* had long been on record. Now the distinction of a prevailing reversed organization must be shared with its Moorean associates, *P. tohiveana*, *P. olympia* and *P. dendroica*.

Like several of the new-found forms already described, notably *P. mirabilis* and *P. aurantia*, *Partula mooreana* proves to have undergone considerable changes during proximate years, and it seems still to be in a state of flux. The proof is double in kind; in the first place we have the intrinsic facts of morphological nature and distribution at the present time, significant on their own merits, and in the second place we have the definite statements of Garrett regarding the characters and localization of *mooreana* in his time, with which the present conditions may be compared. The combined evidences give a complete demonstration that since its discovery and description, *mooreana* has definitely extended its range and has become more diversified than before. Perhaps the most noteworthy new observation is that dextral mutants of great rarity occur, under circumstances which establish their contemporary production.

Garrett discovered the original specimens in Vaianai Valley, about 1875 judging from references in his account of *P. suturalis*. And so far as I am aware, all of the examples of the present species now distributed in the collections of the world were secured by him. Hartman published its first description in 1880.[1] The records next in time are the important comments by Garrett in his comprehensive paper of 1884.[2] Then follows the discussion by Smith,[3] with which are incorporated excerpts from Garrett's letters to Hartman. Pilsbry's treatment of the species in the *Manual of Conchology*[4] is full and complete for the time. The latest item is my own brief statement[5] which is a preliminary to the full account given in the present volume. It is fortunate that at least one species has an unclouded record in which there is no element of confusion, saving only an epistolary suggestion by Hartman that *mooreana* is a hybrid! The original description given by Hartman follows in its entirety.

[1] W. T. Hartman, Proc. Acad. Nat. Sci., Philadelphia, 1880.
[2] A. J. Garrett, Jour. Acad. Nat. Sci., Philadelphia, 1884.
[3] H. H. Smith, Annals Carnegie Mus., Pittsburg, 1902.
[4] H. A. Pilsbry, *Manual of Conchology*, vol. xx.
[5] H. E. Crampton, Amer. Nat., 1925.

"Shell sinistral, ovate, elongate, thin, translucent, pale yellowish horn color, apex darker; whorls 5, flatly convex, body-whorl with or without from one to three narrow, pale brown revolving bands; surface smooth, with fine, oblique striations, which are decussated by crowded waved spiral striæ; a narrow white line beneath the suture; aperture nearly half the length of the shell, lip white, moderately reflected, pillar tooth oval, prominent, situated nearest the superior angle, umbilicus open, moderately compressed.

"Length 18 mill., diameter 9 mill.

Hab.—Vaianai Valley, Island of Moorea (Andrew Garrett, Esq.).

"In one hundred and forty-six species and varieties of *Partula* represented in my collections, this shell possesses constant and well-marked specific characters. Mr. Garrett informs me that fifteen hundred specimens were all sinistral and dentate. The surface of the shell resembles *P. spadicea* and varieties from Moorea in possessing the thickly crowded waved spiral striæ.

"This species is arboreal, and it is not uncommon on bushes in Vaianai Valley, the metropolis of *P. vexillum* Pse. = *P. stenostoma* Ph."[1]

Garrett's statements are of the highest importance, not only because he secured Hartman's material but even more because he was thoroughly acquainted with the whole island of Moorea and with the distribution of Moorean species in his time. His account is erroneous in placing Vaianai Valley on the south*east* coast instead of the southwest. He says (loc. cit., pp. 59, 60):

"This arboreal species is abundant, and restricted to Vaianai Valley, on the southeast coast of Moorea, where it shares the metropolis of *P. vexillum* Pse.

"It may be characterized by its elongate-ovate form, rather thin texture, constant parietal tooth, planulate-conical spire which equals half the length of the shell, pale luteous color, with darker apex. It is *always* sinistral, and the white expanded lip is rather thin and moderately incrassated.

"A variety with three narrow pale-brown revolving bands is not infrequent.

"It is closely related to some of the sinistral forms or varieties of *P. otaheitana*, particularly with Pease's *P. crassa*, which, though of the same shape, is more solid, rougher, and the fine crowded spiral incised lines which extend over the whole surface of the former are nearly obsolete on the latter."

Pilsbry gives an independent diagnosis in the *Manual of Conchology* in which Garrett's error of geographical reference is repeated. It is as follows:

"The shell is sinistral, deeply but shortly rimate, rather thin; dilute yellow, fleshy-corneous or soiled white, the first whorl almost always brown; rarely the last whorl is streaked with buff, or has three pale-brown spiral bands, Surface shining, rather densely marked with spiral striæ throughout. Spire straightly conic; whorls 5, only slightly convex, the last compressed laterally, convex below. The aperture is quite oblique, peristome is well reflexed, strongly thickened within, much narrower in its upper third. Columellar margin dilated at the insertion. There is usually a rather thick but transparent callus and a well-developed parietal tooth. Length 18.5, diam. 11, length of aperture 10 mm.

"Moorea: Vaianai Valley, on the southeast coast."

There are certain details of the foregoing quotations that require emphasis, in view of the outcome of my own analytical studies. The first is that so far as Garrett's knowledge was concerned, *P. mooreana* occurred *only* in Vaianai Valley; reference to the chart will show that this is a member of the outer circle of valleys and not far west of the southernmost point of the island. Now *mooreana* ranges

[1] *Lapsus calami* for Pfr.

more widely in this outer circle and it has crossed the divide to become an inhabitant of several valleys of the inner circle. The second point is that 1500 specimens in Garrett's possession were all sinistral and dentate. Dextral mutants have been found by me in four valleys, while some of my specimens are devoid of the characteristic tooth. The third outstanding point is that a banded color variety "with one to three" (Hartman) or "with three" pale-brown revolving bands (Garrett) was not infrequent. It is unfortunate that no specific proportion is mentioned; we can not judge solely from the relative numbers of the plain and banded shells in museum collections, for it is more than probable that the unusual type would be represented in these collections in excess of its proportions in nature. In point of fact, the characteristic bands of the form in question are two in number and symmetrical, with an additional basal band in some cases and with a weaker sutural band also in rarer instances. My own collections contain three other fasciated types that will be duly described beyond, *two of which are inhabitants of Vaianai Valley*; these are not represented in any of the collections of the world known to me, while there are no references to anything like them in Garrett's works and letters. Presumably, therefore, they are of relatively recent origin.

AREAL RELATIONS

The general census table (table 1) records the absolute and relative numbers of *Partula mooreana* found in certain valleys which are clearly located in the charts of Chapter I. The whole region of present occurrence falls into two contiguous parts, namely a sector of the outer circle from Haapiti to Atimaha inclusive, and a sector of the inner circle from Tefeo on the east to Roroie on the west (plate 13, C). In view of Garrett's assertion that this species was confined to Vaianai Valley, certain possibilities present themselves. Perhaps the species was more widely distributed formerly than Garrett was aware, or he may have been correct and a notable expansion of the area of occupation may have been accomplished since 1875. Finally both of these may be true, that is, the area may have been greater than Garrett supposed and some subsequent extension has come about. The problem is one of outstanding importance and its solution requires the full facts of topographic and demologic nature.

Vaianai Valley is a little less than two miles in radial extent and about a quarter of a mile in width throughout its length. It is bounded internally by a panel of the great mountain crescent which connects two prominent topographic elements—the ridge-like height of Tamarutofa and the peak of Mount Mouaroa. The saddle-like panel in question has an altitude of 1160 feet, and it offers one of the three traversible passes from the outer to the inner regions of Moorea. The ridges bounding Vaianai Valley laterally descend abruptly from the lofty heights of Tamarutofa and Mouaroa respectively to about 900 feet, within a radial distance of a quarter of a mile, and then they slope gradually to their coastward termini. Dense and high vegetation occupies the central portion of the valley to within a half mile of the strand; and a similar clothing of forest spreads upward to cover the inner portions of the enclosing lateral boundaries. The coastward segments of these ridges are

covered with low vegetation so as to offer obstacles to the passage of snails in either direction. Only higher up, where thick growth exists, can migration take place.

Atimaha Valley (plate 6B) is also long and narrow, but it is sharply angled at its outermost third. Its eastward boundary is formed by a ridge like those described above, which descends from the eastern end of Tamarutofa. This eastern boundary is extremely important, for it marks the limit of the range of *mooreana* in this direction and it also coincides with the dividing line between the two major components of *P. suturalis* in this part of Moorea. Paahonu Valley is a lesser element interpolated between the outer halves of Vaianai and Atimaha, and it is limited by forked extensions of the main ridge between the two larger valleys; the enclosing forks are bare of forest toward their coastward ends but higher up they are well bushed. Obviously *mooreana* has entered Paahonu from the higher areas.

Haapiti and Oio Valleys are somewhat like Atimaha and Paahonu in their relations. The former is the larger of the two and a full half mile wide at its head, which is bounded within by the crenellated mountain wall between Mount Mouaroa and Mount Mouapu. The western bounding ridge of Haapiti is only a mile in radial length, while its eastern ridge is a mile and a half long. The point at which the latter divides so as to constitute the fornix enclosing Oio Valley is only about a half mile from the mountain wall. Here again, however, it is only toward the interior that thick forests clothe the ridges so as to permit the entrance of migrants into the Oio area.

With these facts in mind we turn to the question of the presence of *mooreana* in other valleys than Vaianai, in Garrett's time. Garrett does not specify Haapiti, Oio or Atimaha Valleys by name or by indirect reference and he may not have entered them, in which case his explicit statement that this species "is restricted" to Vaianai Valley must be taken to mean *in his experience*. Even so, I believe it can be demonstrated that *mooreana* is a recent entrant into the three valleys named. In 1907 no *mooreana* were found in Haapiti, while in the 1923 collection this species constituted over 9 per cent of the whole population. In the 1919 series from Oio, nearly 9 per cent were *mooreana*, whereas the proportion is 37 per cent for 1923; the latter figure is probably increased partly because this valley was more deeply penetrated than in the earlier year. In the case of Atimaha the figure for 1907 is only 11 per cent, while in 1919 and 1923 the proportions are 55 per cent and 66 per cent respectively. It is true that the collection of 1907 was taken in the lower part of Atimaha, while in the later years the whole length of the valley was traversed; hence the low figure for the first year might seem to mean only that *mooreana* is especially adapted to the upper levels. This is not the case, however. In 1923 the collections from the outer (lower) and inner (higher) parts of Atimaha were carefully separated and analyzed, and it transpired that 60 per cent were *mooreana* in the coastal portion, while 72 per cent of the higher population belonged to this species. Recalling the figure for 1907 it is clear that the species has increased in numbers during recent years, and that it is a little more abundant in the interior than in the outer parts. Hence *mooreana* has unquestionably

migrated into Atimaha from the higher part of Vaianai at a time not very remote. The analysis of the situation to the west of Vaianai leads to a parallel conclusion, namely, that only recently has *mooreana* extended its range into Oio and still later into Haapiti, coming down from the heights in the neighborhood of the head of Vaianai Valley.

Passing now to the inner circle of valleys, it seems that this species has availed itself of the low pass between Tamarutofa and Mouaroa for its migration to the interior, by which path it entered the head of Maramu Valley. Working its way along the heights with thicker bush and greater moisture, it has descended into Tefeo Valley as well as down the length of Maramu Valley—as the comparative figures for the different years clearly show—while to the west it has passed almost horizontally above the dry ridges which descend sharply from the inner wall of the ancient crater to enter Faataofe, Fanautaata and Roroie. The last-named valley is now its present limit. Owing to the absence of a suitable avenue of vegetation, *mooreana* has not been able to descend into Mouroa Valley, which thus constitutes a gap in the east-to-west continuity of distribution. Doubtless in future years it will enter this area from the lower part of Maramu. The absence of any ecological barriers to the east of Tefeo and to the west of Roroie means that *mooreana* has only recently reached the areas in question, and the smaller percentages in these extreme areas corroborate this interpretation.

It is interesting to note that the recent migration of *mooreana* from the outer to the inner circle of valleys is in the reverse direction to that of *mirabilis*, and along the same main way.

Thus the facts assembled in the course of the present investigation prove that *mooreana* has lately extended its range to the east and to the west of Vaianai Valley and also across the main divide to valleys of the inner circle. Whether it was as closely confined in Garrett's time as he supposed is a matter of secondary importance.

STRUCTURAL CHARACTERS

The quotations from the literature fully record the qualitative distinctions of *mooreana* and these need not be restated. The numerous illustrations of plates 19 and 20 and the detailed descriptions of this and of subsequent sections afford a more precise characterization of the shells and of their variations. It is noteworthy that, in contrast with *P. mirabilis* and *P. aurantia*, the aperture is set obliquely with reference to the main axis of the shell and the lip is never beveled as in the two species mentioned.

The sinistral coil of the shell is an outstanding feature. In Garrett's experience with over 1500 specimens from Vaianai Valley this was invariable. Among the collections of the present research, however, sporadic dextral snails have been found in four well-separated localities, and they have obviously been entirely independent in their several origins (plate 20, figs. 13-16).

The only examples in the more original outer area of occupation are two directly coiled immature individuals taken in 1919 in Oio Valley; they were dark and unbanded and at first sight might be mistaken for members of the associated

suturalis series, dextral in nature. But their apical whorls, surface sculpturing, and the sharply angled keels of the young whorls are not what *suturalis* displays, and the hypothesis of mistaken identity is ruled out. While the dextral adolescents of Oio Valley might be interpreted as the offspring of undetected direct adults, this would only put back the episode of mutation to an earlier point, for at some time a dextral individual must have originated from sinistral parents; otherwise we would be forced to regard such dextral examples as relics of an independent stock, parallel in its evolution to the prevalent type. Such a view has nothing to support it.

No evidence of mutation in coil could possibly be more perfect and direct than that provided by a single case in the Tefeo series. A sinistral adult *actually bore in its brood-chamber two dextral embryonic young.* No other dextral individuals were found in that locality.

The collections from Maramu include several dextral individuals, some of which produced young with the perpetuated change, while others reverted. Three such adults were found in the small series of 1909, and one of these contained a single dextral offspring like itself. One other adult bore two sinistral young snails. The third was barren. In 1923 and again in 1924 a solitary mutant was found, but unfortunately in each case it was not gravid at the time.

In the neighboring valley of Faataofe no less than four dextrals were discovered in 1924, although none were seen in 1923; apparently the mutant individuals constitute a small and isolated group, but this must be well on its way to a secure position in the community. In three cases a single sinistral young was carried by a dextral parent. In the remaining instance two young were present, *one sinistral and one dextral.*

This last case is excessively important in connection with the supposed determination of the direction of coil by "maternal inheritance"—a topic first brought up by the single instance of a *mirabilis* which contained young of the two kinds at the same time. Here it is an unusual dextral mutant of a sinistral species which presents the noteworthy facts, while the *mirabilis* was a sinistral mutant of a typically dextral species. Other cases will be described in *P. suturalis*. Collectively they exclude the hypothesis of maternal inheritance as a general one, according to which all young would be somatically like the bearing parent, whatever their own chromosomal factors might be.

The areas in which dextral mutants have been found are well separated. Oio indeed is on one side of the mountain divide while Maramu and Faataofe are on the inner side. A huge dry buttress separates the two latter vallevs and hence the mutants in either could not possibly be migrants from the other. The area of collection in Tefeo is likewise distant from Maramu. Dextral mutation must surely be entirely independent and spontaneous when, as in the Tefeo case, directly coiled young are found within a parent of the usual sinistral type. It is an interesting coincidence that reversed mutants in the dextral species of *mirabilis* came to light in the same two valleys, Maramu and Faataofe, but there are none in the abundant collection of *mirabilis* from Tefeo; no appeal to environmental causation

could be defended, especially in the case of the Faataofe snails, where mutation works in opposite direction from two kinds of parents.

Having disposed of the quality of spirality, we now turn to the significance of the quantitative data which define the several associations of *mooreana* of the old and of the newly invaded territory (tables 65-67). The point of departure is that the associations of Vaianai Valley may be considered as being in a sense more original than those of adjoining regions, and hence their descriptive data (table 65) are the more fundamental. It is clearly shown by the figures that the three Atimaha associations are much smaller and stouter than the Vaianai series; in the matter of length, for example, the former differ to the extent of approximately 10 per cent, which in a comparable human case would amount to several inches. The differences in question almost justify the designation of the Atimaha series as a definite variety in the accepted taxonomic sense, to be called *pygmæa*. To avoid complicating the description, however, the dwarfed associations may be treated along with the others, with due recognition of their local distinctions in structural respects. The possibilities suggested by the facts are (1) that Vaianai shells were generally smaller when the invasion of Atimaha took place, whereupon the former changed to the present average stature while the migrants retained the original dimensions; (2) that the first migrants from Vaianai happened to be small representatives of their kind; and (3) that the first invaders of Atimaha were ordinary individuals whose descendants have progressively diminished in size. In my own opinion the second possibility is the most probable. It is only in the last case that the environmentalist contention could be urged.

The burden of proof rests upon those who would propose the view that external agencies can modify the actual dimensions and the proportions of *Partula* shells. Atimaha and Vaianai are geographically contiguous, and their geological, meteorological and botanical conditions reveal no differences. It is purely gratuitous to postulate some unknown difference in environmental circumstances to account for the observed morphological contrasts of the snails of the two areas; it would be utterly fallacious to assert that there must be causal ecological contrasts because the shells of the two valleys are unlike. If the environment of Atimaha, *per se*, was really responsible for the distinctions of its shells, then we would expect the associated species to be similarly reduced in size; but the representatives of *P. suturalis* and *P. tæniata* of Atimaha do not display the dwarfed condition of the *mooreana*.

The differences displayed by other colonies are less striking but similar in significance. The series of Oio and Haapiti, as compared with those of Vaianai, are relatively larger on the average in the direct measures, even though their proportions are essentially the same. Passing over the divide, the Maramu colonies are clearly much like those of Vaianai, which is to be expected. The two lateral streams of migration by coincidence have culminated in associations of relatively large shells. But there is no discoverable external factor common to Tefeo and to Roroie, at the eastward and westward extremes respectively, which could be invoked to account for the similar trends in structural modification.

The foregoing discussion takes no account of the facts disclosed by an analysis of the color classes, valley by valley; by way of anticipation it may be said that the result of their study is in entire accord with the conclusion based on the comparative array of purely structural characters.

The discussion might be continued more extensively without exhausting the wealth of material evidence against environmental causation of morphological differentiation; but only two more items need be noticed. In the 1919 series from Vaianai where the average length of the shell is 17.11 mm., one specimen was found which was only 14.75 mm. in length (plate 19, fig. 41). This shell is about as short as the smallest member of the Atimaha group, whose collective average is 15.6 mm. If the assumption of external control be made, involving an appeal to undiscoverable circumstances in Atimaha inducing smaller size, consistency would demand a similar appeal in the case of the Vaianai specimen. But this lived among others which were not diminished in size. A "giant" appeared in the Oio series taken in 1919 (plate 19, fig. 46); if some environmental factor were responsible for its novel condition, one might ask what special peculiarity of that area brought it about in Oio alone, and why more giants did not appear in the same locality. Shells with average size but unusual proportions, such as an excessively stout individual in Atimaha, are likewise inexplicable except as congenital products.

For the most part, the shells of the several colonies vary continuously, that is, by small degrees within a comprehensive range. Aberrant individuals occur which fall into three categories. The first kind is symmetrical in proportions, but unusual in some absolute dimension or dimensions, like the dwarf and giant examples already noted. The second is approximately average in general dimensions, but the shell is not balanced in its relative measures which therefore often display very marked departures from the average; cases in point are illustrated in figures 43, 49, plate 19. The third category includes real abnormalities in which, for example, the margin of the aperture is distorted in one way or another, or it bears a prominent tooth (plate 19, fig. 40). In the 1909 series of Maramu, two exactly similar shells appeared with identical structural aberrations in the way of raised revolving ridges; it is possible that these are real mutations, differing from the normal shells, it is true, but normal products of some genetic factors. Finally there are occasional teratological examples, such as a shell which was injured in a young state and repaired as growth continued. A severe cyclone like that of 1906 would certainly cause many animals to fall to the ground and sustain more or less severe injuries. It is interesting to note that the shell in question was collected during the summer of 1907, about 16 months after the cataclysm of 1906.

For the sake of completeness, it is to be recorded that the parietal tooth is generally developed, but not very strongly (table 67). The differences among the several colonies are not especially noteworthy.

In a broad comparison, *P. mooreana* presents more likenesses to *P. olympia* than to any other species of Moorea or of another island. While both are sinistral, exclusively or predominately, this point of resemblance should not be unduly stressed. Two distinct species may arise from a common ancestry and come to be

exact opposites in the direction of the coil, if it is correct to interpret the relationships of *P. tohiveana* of Moorea and *P. formosa* of Raiatea as we have done. A reversed variety of *P. otaheitana*, namely *sinistrorsa*, has become prevailingly dextral in certain localities within its original range; and other illustrations are provided by some of the associations of *P. suturalis* of Moorea. It is worthy of record that *mooreana* and *olympia* have both retained the same coil; apparently they have paralleled one another in their origin from a common ancestry, in the course of the history of differentiation which has culminated in their present specific distinctions.

COLOR CHARACTERS

The original citations from the literature distinguish two general kinds of coloration in *mooreana*, namely the unbanded and the banded. In the present account eight subdivisions are recognized and accorded the major status of color classes. Four of these include unfasciated shells; it would be possible to combine them under the single term **inornata**, as in the case of *tohiveana*, but certain significances would be obscured were this done. The banded type noted in the earlier literature is one of the remaining series. Three other fasciated kinds have been found which are new and quite clearly contrasted with the kind known to Garrett. The distribution of all of the color classes, with their absolute and relative frequencies, is given in table 9.

The most abundant class includes shells with a general light yellowish-brown coloration which are distinguished as **fusca** (plate 19, figs. 43-49). This class is not only the most abundant in the whole collection but it is also invariably present, excluding the indeterminate case of Paahonu Valley. Lighter shells, denoted **pallida** (plate 19, figs. 38-42), are derivatives in one direction. Doubtless many of these shells are paler through decortication, but some are unquestionably light from the very beginning, as embryonic and adolescent individuals attest. The shells of the class called **fulva** (plate 19, figs. 50-53) are much darker brown and often streaked with that color instead of being uniform; this class also is generally present. Finally there are shells designated **phæa** (plate 19, figs. 54-58), which are deep seal brown or at least very dark brown. The **phæa** shells are far less abundant in valleys of the outer circle than they are in Maramu. They are not present in the areas situated at the extremes of the inner circle and are likewise absent from the Oio-Haapiti extreme of the outer territory. In general, **fusca** is the central or standard type of the species as a whole.

In some valleys the shells fall readily and definitely into the specified classes, but in others they intergrade in such ways as to make the divisions somewhat arbitrary; this is especially true in the case of **fulva** and **phæa**. Furthermore a hemisected pattern is displayed in some areas, where one half of the shell may be **fusca** and the other longitudinal half **fulva**, but more frequently the two halves are **fulva** and **phæa**. In *P. mirabilis* of the **phæa** class similar hemisected patterns are sometimes found.

The earlier known type of fasciated shell is here called **frenata** (plate 19, figs. 59-64; plate 20, figs. 1, 2), as it is like the classes of previously described species with

two revolving bands, so designated. Hartman speaks of shells with "from one to three" bands, but the characteristic stripes are really two in number, equally spaced. Some examples possess a basal band as well, while others have a sutural band also. We might distinguish these by other names, as was done in the case of the four-striped quadriga shells of *P. dendroica*, but they are really variants of the frenata pattern in *mooreana* and are not definite enough to justify their establish-

TABLE 9—*Partula mooreana. Census of the color classes*

Series	Year	Total	Sinistral								Dextral		
			pallida	fusca	fulva	phæa	frenata	cingulata	bisecta	zonata	fusca	fulva	frenata
Number of adults													
Outer circle:													
Haapiti	1923	38	8	25	5	...	...	..	..	..	..	..	..
Oio	1919	112	20	86	6	...	...	..	..	..	..	(a)	..
Oio	1923	127	21	97	9	...	...	..	..	..	..	..	..
Vaianai	1907	523	64	378	8	...	73	..	..	..	..	..	..
Vaianai	1919	391	85	290	6	...	10	..	..	..	..	..	..
Vaianai	1923	1,171	143	920	60	3	33	3	9	..	..	..	..
Paahonu	1919	1	1	....	...	...	...	..	..	..	..	..	..
Atimaha	1907	14	7	6	1	...	...		..	..	..	..	..
Atimaha	1919	575	70	403	68	20	10	4	..	..	..	..	..
Atimaha	1923	676	135	431	56	19	9	26	..	..	..	..	..
Inner circle:													
Tefeo	1923	93	15	52	17	9	...	..	..	..	(b)	(b)	..
Maramu	1909	51	7	20	...	...	21	..	..	..	3	..	..
Maramu	1919	98	13	33	21	22	9	..	..	..	..	..	..
Maramu	1923	495	75	182	108	121	8	..	..	..	1	..	..
Maramu	1924	1,092	156	474	189	224	45	..	..	3	1	..	..
Faataofe	1923	212	33	153	23	1	2	..	..	..	..	..	..
Faataofe	1924	228	28	129	56	8	3	..	..	..	3	..	1
Fanautaata	1923	6	1	5	...	...	...	..	..	..	..	..	..
Roroie	1923	56	12	41	3	...	...	..	..	..	..	..	..
All	....	5,959	894	3,725	636	427	223	33	9	3	8	..	1
Percentage of adult population													
Outer circle:													
Haapiti	1923	.....	21.0	65.8	13.2	.....	.....	....	....	....	....	....	....
Oio	1919	.....	17.8	76.8	5.4	.....	.....	....	....	....	....	....	....
Oio	1923	.....	16.5	76.4	7.1	.....	.....	....	....	....	....	....	....
Vaianai	1907	.....	12.2	72.3	1.5	.....	14.0	....	....	....	....	....	....
Vaianai	1919	.....	21.7	74.2	1.5	.....	2.6	....	....	....	....	....	....
Vaianai	1923	.....	12.2	78.6	5.1	0.2	2.8	0.2	0.8	....	....	....	....
Paahonu	1919	.....	(100)	.....	.....	.....	.....	....	....	....	....	....	....
Atimaha	1907	.....	50.0	42.9	7.1	.....	.....	....	....	....	....	....	....
Atimaha	1919	.....	12.2	70.1	11.8	3.5	1.7	0.7	....	....	....	....	....
Atimaha	1923	.....	20.0	63.8	8.3	2.8	1.3	3.8	....	....	....	....	....
Inner circle:													
Tefeo	1923	.....	16.1	55.9	18.3	9.7	....	....	....	.....	....	....	....
Maramu	1909	.....	13.7	39.2	.....	.....	41.2	....	....	....	5.9	....	....
Maramu	1919	.....	13.3	33.7	21.4	22.4	9.2	....	....	....	....	....	....
Maramu	1923	.....	15.1	36.8	21.8	24.4	1.6	....	....	....	0.2	....	....
Maramu	1924	.....	14.3	43.4	17.3	20.5	4.1	....	....	0.3	0.1	....	....
Faataofe	1923	.....	15.6	72.2	10.8	0.5	0.9	....	....	....	....	....	....
Faataofe	1924	.....	12.3	56.6	24.5	3.5	1.3	....	....	....	1.3	....	0.4
Fanautaata	1923	.....	16.7	83.3	.....	.....	.....	....	....	....	....	....	....
Roroie	1923	.....	21.4	73.2	5.4	.....	.....	....	.....	....	....	....	....
All	....	.....	15.00	62.50	10.67	7.16	3.74	0.55	0.15	0.05	0.13	....	0.02

[a] Two dextral adolescents. [b] Dextral embryo.

ment as color orders. Hartman's shells with one band are apparently **frenata** shells with the upper band obsolete, as there are no specimens extant in earlier collections with a single *median* band like that of the next class to be taken up.

Unlike the unbanded shells, except **phæa**, **frenata** is far from universal in its occurrence. It is absent from Oio and Haapiti, and it is also missing in the colonies of Tefeo, Fanautaata and Roroie, which are the extremes of the whole area of occupation of *mooreana*. Apparently it is more abundant in lower Maramu than in the heights, as shown by the comparison of the 1909 figures with those relating to the series of subsequent years; but it is uneven in its distribution in Maramu. It is probable that **frenata** was more abundant in Vaianai in earlier years, that it crossed the divide to Maramu in company with the unbanded migrants, and that it has diminished in relative numbers everywhere in subsequent years.

The class here called **cingulata** is very interesting (plate 20, figs. 3-6). Its diagnostic feature is a single *median* band located in what is the uncolored zone between the two bands of **frenata**. The center of its restricted area of occurrence is the middle portion of Atimaha Valley, as the data of the statistical tables show (tables 68, 70 and 71). Its range extends upward in Atimaha and across the forested heights to Vaianai, where it is very infrequent. The facts indicate that this color mutation originated very recently in Atimaha Valley and that it has not long had an opportunity to disseminate widely. The alternative view, that **cingulata** is a relic of a kind that was formerly spread through wider territory, is opposed by its absence from the abundant series of 1500 shells collected by Garrett. Its origin must be attributed to some spontaneous congenital episode rather than to peculiar environmental conditions in Atimaha Valley.

The next class, called **bisecta**, is the obverse of **cingulata** (plate 20, figs. 7-10); or it may be described in terms of the **frenata** pattern where the color has suffused outward from the major bands to the suture and to the umbilicus. So far as known, this class occurs only in the heights of Vaianai Valley where it is almost as rare as **cingulata**. Its congenital nature and origin by mutation seem unquestionable.

Finally there is a local class of **zonata** shells (plate 20, figs. 11, 12) found in upper Maramu in 1924; only three representatives are in hand. Like the foregoing, this pattern also is interpretable in terms of a **frenata** basis in which the median zone is fully colored as well as the major bands, with the basal and sutural areas strongly pigmented in addition. A rare specimen from Vaianai, taken in 1923 (plate 19, fig. 61), is a true **frenata**, but it displays considerable darkening in its median zone so as to approach but not to equal a **zonata** shell. In this case, as in **cingulata** and **bisecta**, the view is recommended that the distinguishing coloration is the product of very recent mutation.

That all of these classes are genetically inter-related is proven by the characters and relations of the embryonic material.

It is to be expected that the colors of the rare dextral mutants would agree with those of their sinistral associates, and they do. Most of them are **fusca**, but in the Faataofe series of 1924 one is a **frenata**, although that type is by no means abundant in the reversed population.

Reviewing the census figures relating to color composition, it is evident that the several associations vary much in two ways, namely, as regards the kinds that are actually present and as regards the proportions that the existing types bear to one another. Only unbanded classes occur in the extreme valleys of the entire range, and they belong to the relatively lighter orders. The phæa class is much more abundant in the valleys of the inner circle. The rare cingulata class is a component of the Vaianai and Atimaha associations only. Still more notable is the occurrence of bisecta in the upper portion of Vaianai Valley, and nowhere else in my experience. It would be difficult indeed to suggest reasons for these diversities other than the innate, congenital factors which are responsible for the characters of color.

We come now to the last stage in the analysis of the several colonies in which the color classes are compared on the basis of their biometric qualities. The data are given in full in tables 68 to 71. It is neither necessary nor desirable to discuss in detail all of the conclusions to be drawn from them; a few representative illustrations will suffice.

The Haapiti and Oio colonies comprise only pallida, fusca and fulva, of which fusca is the standard class, as everywhere else. The statistical relations of pallida to fusca differ even in the comparison of the 1919 and 1923 series from Oio, in ways that are evident from the figures. In like manner the fulva class varies from its associates in an irregular manner. The conclusion is that the factors of structural qualities and those of coloration are inherited more or less independently.

The Vaianai colonies are particularly important on account of their primacy, as it were, and also because they are so composite. Taking the pallida class as an example, in its relations to fusca, it was about the same in length but more slender in the 1907 series, while in the 1919 series it was definitely longer and slenderer; in the lot secured in the lower valley in 1923 it was about the same as fusca in length but distinctly stouter, while in the upper region it was longer and more slender. Other classes might be dealt with in the same way, with the same outcome, namely, that structural and color characters are not closely correlated. The cingulata class is particularly interesting to follow through. The unique bisecta class, with its small numbers, is closely allied to its associates, in biometric characters.

So far as the Atimaha colonies are concerned, the basic fact is that all classes exhibit diminished stature and stouter proportions with complete consistency, although the frenata class taken in 1923 is relatively larger. The phæa shells of the upper and the lower regions differ in opposite ways from their fusca associates.

When the associations of the inner circle of valleys are scrutinized, identical results are obtained. The frenata class is the most demonstrative as it is followed from one valley to another.

EMBRYONIC MATERIAL

The qualitative points that stand out from the mass of statistics presented in tables 72 and 73 are few and they require only a brief consideration. The general reproductive rate of *mooreana* is average, but perhaps a little lower than in most of the other species, taken during the same season. About 83 per cent are gravid and bear about two items at a time, on the average. It is interesting that the

reproductive rates of the outermost associations are sensibly higher than those of the more central series, notably of Vaianai and of Maramu; the differences in question may be significant.

The eggs are enclosed in opaque capsules as in most species of *Partula*. However, two capsules in one animal were perfectly transparent and only these two out of nearly five thousand in all. The aberration in question exactly parallels what is the universal condition in the variety *P. tæniata striolata* and in whole species, such as *P. hyalina* of Tahiti, *P. radiolata* and *P. gibba* of Guam.

The inheritance of spirality has already been covered in the antecedent discussion of structural characters, although the data belong to the present section. Wherever dextral mutants are found, the question arises as to their stability. The records show that dextral embryos have been found in ordinary sinistral parents, and that some at least of the embryos of dextral mutants repeat the altered parental condition, even if others revert to the original coil. These concrete observations give grounds for the conviction that even very infrequent mutations may constitute the beginnings of a new group within the old association; it is not essential that numerous parallel mutations should arise concurrently. The point in question is one of the most important in the whole problem of the origin of species.

The next question for which the embryonic individuals are valuable is concerned with freedom of interbreeding on the part of the distinguishable color classes; the conclusion is that no restrictions or checks can be discovered. The chief difficulty in the problem is that the fasciated forms of coloration are resolution patterns; the neanic whorls, and usually the metaneanic whorls as well, are evenly and deeply colored with brown, and only later do bands appear when they are developed. The same statement holds for the differences among the unbanded types. However, there are exceptions. Very light young are sometimes found within dark-colored adults, and they are destined to become **pallida**; very dark young, which are certainly destined to become **fulva** or **phæa**, are found at times in lighter colored parents. But the proportionate number of such recognizable individuals never reaches the figure for the adult class as a component of the whole population. The young snails with the evident distinctions are exceptional and precocious.

The **frenata** pattern likewise develops late. Most of the young of **frenata** adults are unbanded, but sometimes they display the characteristic bands. Unfasciated adults bear **frenata** young with sufficient frequency to prove intercrossing.

A most interesting exception appears in the case of the **cingulata** pattern, exhibited only by components of the Vaianai and Atimaha associations. Without citing the detailed statistics, it may be said that the distinctive pattern does appear early, even in the embryonic shells, thus presenting a parallel to the precocious appearance of the **cestata** coloration in *P. olympia*. A second general point is that the **cingulata** coloration seems to be a dominant character, for 15 out of 22 embryonic young contained within **cingulata** parents were similarly marked. The production of a few **cingulata** young by **fusca** parents proves that the novel class is fully capable of breeding with the older, and that it is not so constrained by physiological incompatibility as to be forced to rely upon its own intrinsic fecundity for continued survival.

SUMMARY AND CONCLUSION

Partula mooreana was discovered by Garrett prior to the year 1875, and apparently all of its representatives hitherto known were obtained by that naturalist. The original description was given by Hartman in 1880. Its sinistral mode of coil was perhaps its most obvious distinguishing feature, although it possessed its own combination of lesser differences.

The species was first described as an inhabitant of Vaianai Valley alone. In the course of the present investigations, *P. mooreana* has been found in other valleys of the outer crescent and in adjacent areas within the ancient crater as well. The valleys of its occurrence display no hiatus but stand in unbroken sequential relations; the entire area of habitation is a unit and not divided as in the case of *P. mirabilis*. It is certain from the evidence that the present area is far more extensive than the territory occupied by *mooreana* could have been in earlier decades, as the consequence of active migration on the part of the snails themselves. The topographical and ecological circumstances make it possible to define the roads taken by the advancing organisms as they spread from Vaianai as a center to other valleys of the coastward series, across the divide to Maramu, and thence to neighboring valleys of the inner circle. Whether or not Garrett's explorations were sufficiently complete to justify full reliance upon his statements, the intrinsic facts of distribution at the present time lead inevitably to the foregoing conclusion.

The colonies vary from valley to valley without any discoverable relation to environmental circumstances. The dwarfed stature of the Atimaha associations, the sporadic aberrant individuals of certain areas, and the rare dextral mutants provide the most telling evidence.

The several colonies display marked differences in color composition also. A given association possesses its own combination of color classes which exist in certain numerical proportions that are not duplicated elsewhere. As in the case of the structural characters, the real factors for the colonial differences are congenital.

Mutation is exhibited in the structural feature of spirality, and independently in several localities. Likewise color mutation is demonstrated by novel types undiscovered by Garrett. The reasons are given for the belief that even single mutants are sufficient for the institution and spread of a new component group within its parent association, even when intercrossing with older types still continues. The most important but not the sole illustration is that of the **cingulata** color class.

Considering the extrinsic relations of the species as a whole, it seems probable that it has had a common origin with *P. olympia*. The ancestral stock must have been somewhat widely disseminated over the island in remote times. Subsequently most of its representatives disappeared, leaving at last the *pro-olympia* association in Mouaputa Valley, and the *pro-mooreana* relic in Vaianai Valley. The former has remained sparse in numbers and in danger of complete extinction; but the latter passed into a new era of active increase in numbers, wider expansion, and intrinsic differentiation. Each episode of this history has its proven counterpart in the case of some other species or variety, and is not purely theoretical or uncorroborated.

CHAPTER XI

PARTULA SUTURALIS Pfeiffer

GENERAL CONSIDERATIONS

We are now to deal with the second of the long-known species of Moorea, *Partula suturalis*, which as a whole presents many features of contrast with all of the foregoing. As far back as 1855 it was established on the basis of specimens collected by Cuming, although the habitat was not correctly recorded at that time. Representatives of its sub-species are numerous in all of the collections of the world. It now exists in substantial numbers in nearly every habitable valley of Moorea, with the notable exception of those of the Rotui sector which, however, are occupied by its relative, *Partula dendroica*. One agreement with the foregoing species consists in the recent enlargement by *suturalis* of its area of occupation. In its entirety, it stands between *P. mooreana* and the remaining species, *P. tæniata*, as regards the extent of its whole territory, its numbers and its colonial differentiation.

My own collections comprise 14,640 adults, 5890 adolescents, and 12,922 embryonic individuals, or 33,452 in all. They represent the populations of all the valleys where the species occurs and form series taken both during the earlier and later years of the investigation, in the case of very nearly every colony.

It is evident that this material possesses a high value for the problems of distribution, variation and evolution. The data of colonial diversification are abundantly satisfactory and relate to associations of one and the same species, with only two major varieties, located in a wide expanse of the island; therefore the question of environmental interposition can be more confidently treated than before. Although they are not to be accepted literally without critical examination, Garrett's circumstantial statements are available as a description of the nature and distribution of *suturalis* in his time, with which we may compare the species as it was in 1907 to 1909, and as it had become by 1919 to 1924. The entire complex of qualities displayed by *suturalis* as regards area, variation and change discloses its condition of evolution as a whole, which condition is interpretable in terms of what is displayed by a less advanced species like *P. mooreana*, while in turn it provides certain requisites for a fuller understanding of the more differentiated assembly of varieties constituting the remaining complex species, *P. tæniata*.

The outstanding importance of all of these considerations and the volume of the material itself make it necessary to treat *suturalis* in considerable fulness, although every effort has been made to condense the account to its smallest effective compass, and much has been omitted that would be useful, if not indispensable.

Pfeiffer's original description[1] as quoted by Pilsbry[2] is as follows:

"Shell narrowly perforate, oblong-conic, thin, distinctly striate spirally; fulvous-buff irregularly painted with chestnut streaks. Spire convexly conic, acute; suture mar-

[1]Proc. Zool. Soc. London, 1855.
[2]*Manual of Conchology*, vol. xx.

gined with a white thread. Whorls 5½, slightly convex, the last slightly shorter than the spire, somewhat swollen above, tapering toward the base. Columella nearly simple, almost vertical. Aperture slightly oblique, truncate-oblong; peristome white, thin, the right margin narrowly expanded, sinuated above, columellar margin dilated, reflexed. Length 19, diam. 9, aperture with peristome 10 mm. long, 4¼ wide inside."

To one familiar with an abundance of *suturalis* material, it seems strange that the foregoing description refers to an unbanded type of shell, because the fasciated kinds are far more numerous in almost every valley of the range. Cuming may have been content with the first few examples he discovered, or he may have collected some of the striped kinds and included them in the lot sent to Pfeiffer, who may have deemed them less characteristic than the unbanded examples. If so, undoubtedly he would have referred to the fasciated color patterns.

Large series of specimens were collected by Garrett from 1861 on, and were sent by him to Pease, who was struck by the two-banded color form and described it as a full species, *P. vexillum*. In point of fact, *vexillum* must be treated as a variety of *suturalis*, and indeed it proves to be the more characteristic as well as the more wide-spread of the two primary components of *suturalis* as a whole. Pease's description[1] is given both in Latin and in English, the dimensions being stated only in the former. Combining the important elements, it is as follows:

"Shell somewhat fusiformly ovate, turrited, umbilicate, solid, dextral, somewhat glabrous; whorls 5, planely convex, suture well impressed and sometimes marginated; aperture ovate, vertical, dentate, rounded at base; lip narrowly, evenly, and somewhat roundly thickened, straight on its outer edge and slightly angulated above. Yellowish horn color, ornamented with two dark chestnut bands or lines, and generally same color at umbilicus. A single specimen was found wholly dark reddish chestnut.

"Dimensions: Long. 20, diam. 10 mill.

"Observations: The above species has been confounded with *lineata* Lesson, as well as *elongata* nob., to which refer for my remarks."

Under the name of *Partula strigosa*, the second variety of *P. suturalis* was described as a distinct species by Pfeiffer,[2] who did not perceive that the shells in hand were closely related to his *suturalis*. He characterized them as follows:

"Shell perforate, oblong-conic, rather solid, very obsoletely decussate, subopaque; whitish, ornamented with irregular fulvous and rufous streaks. Spire conic, the apex acute. Whorls 5, nearly flat, the last slightly shorter than the spire, somewhat tapering at the base, rounded. Columella somewhat twisted above, subnodose at base. Aperture slightly oblique, truncate-oval, generally contracted by a nodiform parietal callus. Peristome white, callous, subequally spreading throughout. Length 17 to 18, diam, 9 mm., aperture with peristome 8½ x 6½ mm., inside 3½ mm. wide. Admiralty Islands."

Pease described the identical variety as *Partula alternata* in manuscript, as cited by Smith,[3] but all authorities including Garrett agree in the use of the prior name, *strigosa*.

We now came to the full account given by Garrett of the nature and distribution of *suturalis* as he understood them.[4] It is true that he identified the

[1]Amer. Jour. Conchology, 1866, p. 198; 1867, p. 81, plate 1.
[2]Proc. Zool. Soc. London, 1856, p. 388.
[3]Annals Carnegie Mus., vol. 1, 1902, p. 407.
[4]Jour. Acad. Nat. Sci., Philadelphia, vol. IX, Part 1, 1884, pp. 50-52.

species with Lesson's *lineata*, and explicitly denies its correspondence with Pfeiffer's *suturalis*; but even before his monograph appeared in print, he changed his stand and disavowed his former opinion in a letter to Hartman (January 5, 1884), in which he said "I think Lesson's *lineata* may be considered a lost species. I regret using the name in my paper."

Garrett's statements are here quoted in full for purposes of immediate reference, on account of their fundamental importance.

"This beautiful arboreal species is found in great profusion in Vaianai Valley, on the southeast coast of Moorea, where it occurs in company with *P. mooreana* and *P. elongata*. It also exists in considerable numbers in a small valley about two miles to the westward, associated with *P. tæniata* and *elongata*.

"I first discovered this species in 1861 and obtained several hundred specimens, *all* collected on the eastern side of the stream that flows through the valley of Vaianai. They were *all* dextral, and were so described by Pease, under the name of *vexillum*. On a second visit, in 1875, I took over 2000 examples, *all* gathered on the *western* side of the stream, and was surprised to find many sinistral forms among them. At the same time I found about a dozen specimens, *all* sinistral, in a large semicircular valley on the opposite side of the island. They were probably stragglers from Vaianai.

"It is noteworthy that no reversed Partulæ were found in any other part of the island except on the western side of the stream in Vaianai, and the above-mentioned stragglers taken on the opposite coast. The same side of the stream is also the home of the sinistral *P. mooreana*.

"Several miles to the eastward of Vaianai, in a large valley named Oahumi, it is found equally as abundant as in the former location. The Oahumi shells, which are slightly modified (= *strigosa* = *alternata*), gradually inosculate with *lineata*. It occurs, also, sparingly in a valley more to the eastward, where it is associated with *P. tæniata* and *striolata*.

"The type is luteous, or straw yellow, rather shining, and girdled by two or three narrow, equidistant reddish chestnut bands. The shell is comparatively thin, compressly perforated, more or less wrinkled by incremental striæ, and the fine spiral incised lines are generally obsolete on the last whorl. The produced spire is a trifle more than half the length of the shell. The rather small aperture is truncately oval, and the parietal tooth is seldom absent. The white peristome is rather thin, moderately expanded, lightly labiated within, and rarely with a slight sinus above. The columellar lip is receding above at its junction with the parietal wall.

"Length 19, diam. 10 mill., which are about the average dimensions.

"The following color varieties occur:

"Var. a. Uniform chestnut brown, approaching blackish brown, with a pale sutural line. Rare.

"Var. b. Dark chestnut brown, with a wide, median, luteous band on the body-whorl. Rare.

"Var. c. Luteous or straw yellow, with a very broad, deep, chestnut band on the middle of the body-whorl. Rare.

"Var. d. Luteous, with faint, longitudinal, light fulvous-brown strigations. Common.

"The sinistral examples, of which I obtained fifty, exhibit the same variation as the dextral shells.

"Contrary to the opinion of Messrs. Pease and Hartman, I follow Reeve, Pfeiffer and Carpenter in referring this species to Lesson's *lineata*, which that author erroneously accredited to Oualan or Strong's Island, one of the Caroline group. Lesson either collected his specimens at Moorea, or he received them from some of the foreign residents at Tahiti,

and as was *too* frequently the case with the naturalists of the exploring expeditions, he had forgotten the correct habitat.

"The following is a translation of Lesson's brief description:

" 'Shell perforated, oblong-oval, luteous, with two fulvous bands; spire conical, whorls six, slightly convex, last one as long as the spire; aperture oval; peristome expanded; columellar margin much thickened within. Length 8, diam. 5 lines. Hab. Oualan Island.'

"So far as the description goes, it coincides with the pale, banded, edentate Moorea shells.

"Reeve describes it as follows:

" 'Shell acuminately oblong, umbilicated, rather thin, whorls six in number, spirally very finely striate, light fulvous, sub-transparent, encircled with two distant chestnut bands. Lesson, Voyage de *la Coquille*, p. 324, plate VII, figs. 8, 9. *Hab.* Friendly Islands' (Reeve).

"Like Lesson, he does not mention the parietal tooth, which is well expressed in his figure. His description is from examples in the Cumingian collections, and is certainly the Moorea shell. His habitat 'Friendly Islands'—Tonga, *is* incorrect. Only one species (*P. subgonocheila*) inhabits that group.

"Pfeiffer, in his *Monographia Heliceorum*, vol. III, gives a more detailed description of *lineata*, also from specimens in Cuming's collection, and cites 'Oualan et Eimeo' (= Moorea) as location, but in his subsequent volume omits the latter location. Like the two former authors, he does not allude to the parietal tooth. However, he makes the same omission in two other dentated species.

"A careful comparison of Pfeiffer's description of *P. stenostoma* and *lineata* has convinced me that they can not refer to the same species. The latter is undoubtedly the Moorea shell. The former, according to the measurements, refers to a larger and more robust shell, being, in fact, the same size and proportion as *P. planilabrum*. In Pfeiffer's original diagnosis he says 'læte castaneo bilineata,' and in his Monograph, 'læte castaneo trilineata.'

"The Oahumi shell which was described by Pfeiffer under the name of *strigosa* is, by some authors, affiliated with *P. nodosa*, an entirely different species, inhabiting a limited area in Tahiti. Mr. Gloyne and Dr. Hartman first pointed out its very close relationship with *P. vexillum* = *lineata*. Indeed, the inosculation is so complete that they must be considered one and the same species.

"The Oahumi shells are usually a trifle smaller, not so frequently dentated, and are much more conspicuously strigated than the Vaianai shells. The spiral bands, of which there are one or two, seldom three, on the body-whorl, are very frequently interrupted, which, with the conspicuous strigations, gives the shell a somewhat tesselated appearance. All the color varieties alluded to in my remarks on the Vaianai shells are also found in Oahumi, but the uniform dark-colored ones are more frequent, besides one of a uniform white color, not decorticated, of which I took three examples.

"So far as I can ascertain, there has been no figure published of Pfeiffer's *strigosa*. He gives the Admiralty Islands as its habitat. There are *no* species of the type he describes found in the western Pacific. It is undoubtedly a Society Island species, and I fully agree with Dr. Hartman in referring it to the shells under consideration. The description is sufficiently near to justify the identification. But I can not share the above author's view in regard to Pfeiffer's *P. suturalis* being = *strigosa*. There is too much discrepancy in the two diagnoses to warrant their affiliation.' "

There are many items of this lengthy discussion that require comment at this juncture; and they are matters both of areal relations and of intrinsic character. Vaianai Valley is specified as the headquarters, and actually this valley is located

in the southwest region, and not the southeast, of Moorea. The small valley "two miles to the westward" is clearly Uufau. At once a most important point comes out; nowadays *suturalis* is largely sinistral in Uufau Valley. If there had been any reversed individuals in that area in Garrett's time, assuredly he would have noted their presence. He makes much of the sinistral snails in Vaianai, in the very next paragraph, thus furnishing the data for an exact determination of the proportions of the two kinds in the original Vaianai series. The "dozen specimens, all sinistral" taken on the opposite side of the island are very important for the analysis of the areal relations of the species as a whole, to be discussed at a later point.

Reverting to the outer coasts, Garrett records the species from what he calls Oahumi Valley, which is really Haumi Valley ("the humid region"). He makes no mention of Atimaha, a near neighbor of Vaianai, or of Maatea Valley. The former bears snails like those of Vaianai, while the latter, like Haumi, is inhabited by the variety *strigosa* which Garrett correctly assigns to Haumi. Then Garrett indicates the extreme limit of the range of *suturalis* as a valley more to the eastward where its associates were *P. tæniata* and *striolata*; this is Vaiare Valley without question. It is noteworthy that no mention is made of the forms of Maatea, or of the great valley of the Afareaitu section named Hotutea; we can only conclude that Garrett did not explore these areas, doubtless assuming that their types conformed to what he discovered in the valleys actually visited.

The list of color types is valuable, even though it lacks definite numerical data as to the relative frequencies. The words "rare" and "common" are very vague and unsatisfactory. But at least the list indicates the kinds Garrett actually found.

The problem of the real *lineata*, so fully discussed by Garrett can not be settled without actual exploration of Oualan, or Ualan, as it should be spelled. As noted earlier, our author changed his views concerning Lesson's *lineata* as applying to the Moorean species; but nowhere does he specifically retract his final statement, namely, that Pfeiffer's *suturalis* can not be *strigosa*. His description of the *strigosa* shells in the Haumi region is accurate, and it adds a type with a single band to the list carried over from the Vaianai association; the added type is a most characteristic one in all of the *strigosa* colonies.

Pilsbry's *Manual* also gives considerable space to *P. suturalis*, under that name. Pilsbry explicitly distinguishes *vexillum* as a variety of *suturalis*, and he recognizes *strigosa* "as a form" of the same species. By implication, *Partula suturalis* is a true species with local specialized varieties, to be called *vexillum* and *strigosa*.

My own detailed studies have led to the opinion that the species as a whole comprises two primary varieties, *Partula suturalis vexillum* and *Partula suturalis strigosa*, distinguished by differences in size, shape and coloration; their areas of occupation are also separate and do not overlap. The latter variety exists in the valleys of a small sector of the southeast region from Maatea to Atiraa Valley, while the former claims all of the rest of the extensive series of valleys in the crescent of mountains that constitute the prominent topographic feature of Moorea. Evi-

dence will be presented that *strigosa*, conservative in its characters, has remained within the confines indicated by Garrett, while *vexillum*, on the contrary, has widely expanded its range in proximate decades, and at the same time has undergone very remarkable changes, especially in the character of spirality.

AREAL RELATIONS

When the geographic distribution of *P. suturalis* as a whole is surveyed in a broad way, the most obvious feature is the wide extent of the territory of occupation (plates 13B, 14); only in the case of *P. tæniata* is this exceeded. The species ranges throughout the whole mountain circle and in practically every valley without a definite hiatus; the Rotui sector is explicitly excepted. This is strictly true, in my experience, so far as the uppermost portions of the valleys are concerned, for the animals of this species are always to be found at the highest altitudes even if they do not come down to lower levels in every place. In the general census table entries for this species are lacking here and there, sometimes because collections were made near the coast and not in the highest interior—for example, the Moruu series of 1907 and the Paparoa series generally. Sometimes this is the case because the valley in question is an interpolated coastward element, which does not extend inwardly to the main mountain wall, as in the case of Vaipua.

With the present wide distribution as an assured fact, the immediate task is to examine the several colonies to see what evidence is disclosed that *suturalis* was not so widely extended earlier, and that its present limits have been only recently attained. And for this purpose the details of Garrett's account must be critically examined. It is true that the qualities of spirality, coloration and size, by which the primary varieties are distinguished, are important data for the problem; but these are not absolutely indispensable for this part of the discussion.

In Garrett's account it is definitely stated that the headquarters of *suturalis* was Vaianai Valley, and it is further stated that the species existed in a valley two miles to the westward, which is certainly Uufau Valley. Garrett does not mention the intervening areas of Oio and Haapiti, and it remains an open question whether he actually made collections in them, or was content with the assumption that their species were identical with those of Vaianai and Uufau. But the point of real importance is that the valley identified as Uufau is indicated as the western limit of *suturalis*. It may be held as certain that Garrett actually did explore the region still farther west, because his account of *tæniata* distinctly states that a variety of the species, namely *simulans*, existed in three valleys of the southwest tier, and the *easternmost* of these is Vaianai. Clearly, then, he had collected snails in at least one valley to the northwest of Uufau; which one it might have been is less important than the implication that it was not inhabited by *suturalis* at that time. An additional point is that Garrett's rectified chart (text-fig. 5) does not record *suturalis* beyond Uufau Valley.

Today this species occurs in substantial numbers in Moruu, Varari and Maraarii Valleys, and in smaller numbers in Pafatu Valley—the most extreme member of the outer circle in the northwestern direction. In 1907, *suturalis*

The present distribution and nature of *Partula suturalis*; the arrows show the directions of dispersal of *Partula suturalis vexillum*.

constituted 0.32 per cent of the *Partula* population of Pafatu, while in 1919 it formed nearly 5 per cent. Even when allowances are made for the possibility that Garrett did not explore every valley, and for the further contingency that he did not penetrate deeply into the valleys of the northwest, the facts indicate that the extreme territory in this direction has only recently been occupied by the present species. It must have worked its way along the forested heights, descending to lower levels where thick vegetation in the mid-valleys afforded opportunities. The species may well have been present in the upper levels of the northwestern region in Garrett's time, even though it had come down in substantial numbers only in Uufau Valley.

The problem of the central areas involves many uncertainties. The only datum given by Garrett is his reference to "a dozen specimens, *all* sinistral, in a large valley on the other side of the island." The general region in question must be the wide, open expanse of the Opunohu basin. But this area is in reality a composite one, for its habitable borders along the mountain wall are numerous subsidiary forested tongues connected only along the the higher cliffs of the ancient crater. The snails are by no means the same throughout these subsidiaries; the combinations of species differ from one to another, while the representatives of one and the same species are not alike in all places.

While we can not determine with certainty where Garrett found his reversed examples in the Opunohu region, yet the intrinsic probabilities indicate one of two localities, namely, Maramu Valley and Vairahi Valley. There are two major streams which drain the Opunohu basin; the main body of the first collects the waters from the central area where Maramu, Tefeo and Mouaroa are located, receiving the stream from the eastern areas not far within its mouth. The other and larger stream is formed by the numerous feeders flowing from the subordinate divisions of the western part of the whole basin. A collector would inevitably follow a water-course on account of the easier gradient, smoother terrain and thicker forest along its banks.

On the assumption that Garrett penetrated into Maramu, his "stragglers from Vaianai" would exemplify an association of migrants with the reversed character of the shell, in which they resembled the sparse sinistral individuals found by him in the outer valley. Today all *suturalis* in Maramu Valley and environs are dextral. If the primary assumption is correct, then a complete return to the direct mode of coil has come about on the part of the descendants of the first migrants across the natural pass from Vaianai to Maramu. The species may have been prevailingly sinistral when the migration took place, and subsequent decades may have witnessed the change from sinistral to dextral in the parent area, and also in the tier of valleys of the inner circle from Maramu westward to Fanautaata and from Maramu eastward to Paparoa. In view of demonstrated changes of like nature elsewhere, this history is not at all improbable.

If we assume, on the contrary, that Garrett found his unusual specimens in the western part of Opunohu in or on the way to Vairahi, then the migration which brought their antecedents there must have been much earlier. Then, as

now, colonies of *suturalis* must have been present in the intervening valleys between Maramu and Vairahi, where Garrett did not find them because his survey was not complete in detail. The one assured fact is that the animals he discovered were sinistral. Regarding their kind as the advance of a great wave of expansion, they may have come from dextral migrants by mutation or the original stock may have been reversed; in the latter case they would be the conservatives in the quality of coil while the snails remaining in the original territory would be the ones which have changed. It is interesting that the concluding points of this and of the preceding paragraphs should be the same.

The situation in the farther northwest is important. Urufara Valley was visited in all years except 1919. In 1907 *suturalis* constituted 2.47 per cent of the whole *Partula* population of the main central forests; its proportions had increased to 6.33 per cent by 1909 in the same region. More detailed surveys were made in 1923 and 1924, when *suturalis* constituted 9.02 per cent of the population in the original area. Higher up, near the pass by which migrants must have entered Urufara from Vairahi, 18 per cent of all adult snails were *suturalis*. The greater abundance at the heights and the increased numbers at lower levels prove conclusively that this species has not long been an inhabitant of the Urufara sector. The larger numbers in the north central subdivision represent an independent stream of migration downward along the ridge which constituted the eastern boundary of Faatoai Valley, as the difference in color composition clearly shows.

Faatoai Valley itself bears relatively few representatives of this species, not because it is unsuitable but apparently because it has only recently been invaded by the kind. The lower levels everywhere and the central area of Teea are completely devoid of *suturalis*. Such individuals as are present occur in an area with the form of a thin crescent, located at high altitudes where the forests articulate with those of Urufara to the east, Vairahi to the south, and westward with the thicker bush distributed along the ridge which separates the whole Faatoai basin from the coastward valleys stretching from Pafatu to Moruu. The character and location of the crescent in question, like the sparse numbers, indicate a recent occupation of Faatoai.

Having dealt with the colonies' spread northwestward from the central region of Vaianai and Maramu, we return to the latter valley in order to follow the sequence of associations in the northeastward direction. The colonies are dextral all the way to Paparoa, in which locality the snails of this species are few; they are dwellers in the heights although there are no discernible ecological reasons for their absence at lower levels. The line of migration then passes across the divide to the Vaiare sector. Today *suturalis* could hardly be regarded as "sparse" here, as Garrett described it for his time. In the Puutu division, the species formed 14.6 per cent of the population in 1907 and 26 per cent in 1919. As no change in ecological conditions had come about since 1875 it is safe to conclude that this is due to the natural spread of recent immigrants into the area. The Vaipohe figures for 1919 and 1924 are inconsistent with the foregoing, it is true, but the reason is that in the earlier year more attention was paid to the novel species *P. aurantia* and less

to *suturalis*. The larger number of *suturalis* in the 1919 collection from Faamaariri are explained by the fact that the series was taken in the higher portion of this subdivision, while the collection of the later year was secured lower down. It may be noted here that the Vaiare series comprise both dextral and sinistral members, and thus differ from the inner colonies of Paparoa and Mouaputa, whose components are all dextral.

In Tepu and Maharepa, where the snails of this species are exclusively sinistral, they are found sparsely at high levels only, although suitable vegetation exists in profusion lower down. Here the situation is like that in Faatoai, and it indicates that this territory has not long been occupied. The absence of *suturalis* from Paraoro and Farehotu on the inner side may also be significant in this connection.

All of the foregoing discussion relates to *Partula suturalis vexillum*. The case of *Partula suturalis strigosa* is very much simpler. The only definite datum supplied by Garrett is that this variety existed in Haumi Valley. It is true that his chart, which is quite out of proportion in its original form (text-fig. 4), indicates a wide spread of *strigosa*, under its later name of *alternata*. In my opinion, Garrett assumed this wider range and did not define it on the basis of a complete exploration of all the valleys between Vaianai and Vaiare. The indicated association of *striolata* and *strigosa* is an error that probably arose from an assumption by Garrett that the sparse *suturalis* in Vaiare were *strigosa* instead of *vexillum*. It is possible, of course, that the representatives of *suturalis* which Garrett found in Vaiare were *strigosa*; if so, their kind has disappeared completely and their place has been taken by the *vexillum* which came across the divide from the central region. But I incline to the former explanation.

Today the boundaries of the sector occupied by *strigosa* are sharp and definite. The great ridge descending from Mount Tohivea in a southward direction (plate 6B) divides the territory of *strigosa* to the east from that of *vexillum* to the west. In a similar manner, the main buttress descending outward from Mount Mouaputa (plate 5A), that forms the southern wall of the Vaiare basin, constitutes the northern limit for *strigosa*. Five distinct valleys lie in this sector, of which the first, Paia, is a small interpolated coastward element. All of the others extend inward to the main circle of mountains. Vaipua is like Paia—a small shallow area to the north of Atiraa—but its conditions are unfavorable for *suturalis*, which is therefore absent.

Reviewing the essential results of the foregoing discussion of areal relations, we may reconstruct the history of the species. It is an ally of *P. dendroica* which dwells in certain parts of the Rotui sector. The prior ancestral stock of these two species must have been wide-spread in ancient times when Moorea was less eroded and higher above the sea. The numbers dwindled with time, the continuity of their range became broken, and contrasted portions of the parental stock became isolated; one relic remained in the Rotui sector and another in a contracted series of coastward valleys. The former gradually assumed the distinctions of *P. dendroica* of today. The latter differentiated into two subordinate kinds—the forerunners of *vexillum* and *strigosa*. The second variety of *suturalis* has remained in close

confinement in the valleys from Maatea to Atiraa, where it gained its differential qualities. In marked contrast, the first has expanded its territory widely, and it has greatly increased in numbers so as to occupy almost all of the island except the Rotui sector and the compact region held by *strigosa*. The time when the great expansion took place can not be determined with certainty, but it must have begun at least a half-century before Cuming discovered the first examples of *suturalis* and sent them to Pfeiffer, judging from what Garrett definitely describes for the decades of his studies.

The conclusions drawn from the study of *P. aurantia*, *P. mooreana* and *P. mirabilis* are exactly similar to the above. What has occurred in these species during relatively recent times makes it possible to portray earlier episodes in the history of *suturalis* with some confidence.

PARTULA SUTURALIS VEXILLUM Pease—STRUCTURAL CHARACTERS

The several characters which distinguish *Partula suturalis* as a whole and *P. suturalis vexillum* as a primary variety have been duly enumerated in the first section of this chapter. With the exception of the fine details of sculpturing, they are well displayed by the illustrations of plate 20, figures 17 to 51, plate 21, figures 1 to 30, and their contrasts with the diagnostic features of other species are evident. The material comprises many thousands of shells which represent the colonies of a wide territory; despite the use of numerous illustrations, it is impossible to do full justice to their inter-colonial and intra-colonial diversification. When extreme variants are shown together with a few specimens of average nature, the preponderance of the latter over the former is incapable of demonstration. And the modes of variation from an average colonial condition are so numerous that they can not be adequately presented. The representatives actually shown must be accepted with these considerations in mind.

We may first deal with the data relating to the nature of the local colonies as regards the modes of coiling of their shells, having in mind the general results of the comprehensive analysis of areal relations. Three groups of facts are available: Garrett's statements regarding certain colonies in his time, my own personal observations for the period from 1907 to 1909, and similar personal observations for the years from 1919 to 1924. The general census table (table 1) gives the figures relating to my own collections, and the principal features of the situation are shown in plate 14.

The species was fundamentally dextral in 1875, but the Vaianai association of the time included a sinistral group amounting to 50 out of 2000 individuals, or 2.5 per cent. My own collections from Vaianai, taken in 1919 and 1923, comprised fewer *suturalis* than in 1907, partly because other species received particular attention and also, I believe, because *suturalis* had actually diminished in numbers in that locality. Combining them all, none was sinistral among 774 individuals of all ages—adult, adolescent and embryonic. While it is possible that sporadic reversed individuals did occur, escaping observation, on the other hand it is at least probable that the sinistral component noted by Garrett had not perpetuated itself.

In Oio Valley, the 1919 series comprised 1.3 per cent of sinistral snails in a total *suturalis* collection of 612, while none were found in 1923, and in this case it is practically certain that a prior sinistral component had disappeared. The series from the next valley, Haapiti, give exactly the same result; nearly 8 per cent of the *suturalis* were reversed in 1907 but none at all were found in 1923.

The area of Uufau Valley is most important. It was here that Garrett found *suturalis*, as we have shown, and by direct implication its representatives must have been dextral in his time. When the collections of 1907 were assorted, 87.78 per cent of the adults of this species proved to be sinistral, thus showing that an extraordinary change in the colony had come about in the interval. When the embryonic young of the 1907 series were scrutinized, they were reversed in the proportion of 87.29 per cent; and while the difference is slight, it suggested that a return had set in from the sinistral to the dextral complexion. The figures for the 1923 series prove that this was the case. In the later year, sinistral adults amounted to 70.7 per cent, while their own young were reversed in 68 per cent of the cases. An exhaustive analysis of the relations between parents and offspring shows that the reproductive rates of the two types are essentially the same, with the dextral group slightly more fecund, that the majority (82.5 per cent) of the young borne by the reversed adults are similar in coil, and that the majority (64 per cent) of the young borne by dextral parents are likewise direct in coil. Therefore the change of the colony as a whole is not due to a superior degree of fecundity on the part of the dextrals or to a deficiency in the rate of the sinistrals, but it is brought about by a genetic preponderance of dextral young among the offspring of directly coiled individuals. The net result is a lowering of the percentage of reversed snails in the community as a whole; this result is in complete accord with the findings in Vaianai, Oio and Haapiti.

Passing further northward through the colonies of the outer circle, all of the *suturalis* found in Moruu in 1909 were sinistral, while one dextral appeared in the series of 1923. Here it is an open question whether the novel individual was a migrant from Uufau and a representative of a sparse stock not previously known or a real mutant from a reversed parent. There is no uncertainty, however, in the case of a single *dextral young found in a sinistral parent*, in the Maraarii series of 1907.

Collating the foregoing data, it is evident that what may be called a genetic wave of sinistrality had spread northward from the Vaianai region to the outer districts, and that this had been followed by a general return to the dextral mode in Vaianai, Oio and Haapiti; the colonies of Uufau seem to be in process of return, while the Moruu associations may be only beginning to revert. Collections in future years will possess the greatest value for a final judgment on these points.

When we pass to the inner array of valleys from Maramu northward, we find only dextral colonies as far as Roroie. The associations of the next region, Morioahu, contain minorities of dextral individuals which diminish to sparse numbers in the Vairahi territory beyond. This last area articulates with Uufau by way of the low pass between Mount Atiati and Mount Mouapu (plates 9B, 12A); but if the situation within the mountain circle had been materially influenced by that which

maintains in Uufau, we should expect more dextrals in Vairahi and its environs than in Morioahu Valley. It is more probable that the character of the Vairahi colonies has been determined by the original stock which migrated into this part of Moorea from Vaianai by way of Maramu and the intervening valleys of the inner circle.

Tupuna Valley is adjacent to Vairahi, but on the side toward Opunohu Bay; here *suturalis* is mainly sinistral, but four dextral adults were taken in 1923. In the same year one dextral adult was found in the prevailingly reversed colony of Vaiana, adjoining Tupuna. These instances prove that dextral mutation is taking place in associations of dominant sinistral nature, and they suggest the coming of the same kind of genetic wave that has affected the colonies of the outer array.

Urufara and Faatoai bear only sinistral representatives of *suturalis*. As we have seen, these areas have not long been inhabited by this species, and presumably their associations represent the original forefront of the tide of migration from the ancient headquarters.

Returning to Maramu we follow the avenues along which *suturalis* has spread to the northward. All the way to Mouaputa this species exists in the dextral form only. Reaching Paparoa, it becomes scarce in the collections, mainly because it lives high up near the mountain wall itself. As already noted, it was not found in the valleys of Paraoro and Farehotu, bordering Paopao Bay.

Crossing the mountains to Vaiare, and thus passing around the area where *strigosa* occurs, true *vexillum* is found in the sinistral as well as the dextral form. As in Uufau, adults of each kind bear young of the opposite coil, and in Faamaariri both kinds of young have been found in the brood-chamber at the same time in a few instances which duplicate the rare cases described in *P. mooreana* and *P. mirabilis*. If the figures for the Puutu series are trustworthy, some relative increase of the reversed component had taken place from 1907 to 1919; the data for the Faamaariri series are conflicting, even when all allowances are made. Finally, in Tepu and Maharepa only sinistral representatives of *vexillum* occur, precisely as they do at the extreme northwest, in the opposite direction.

Briefly summarizing the essential points, it appears that colonial changes in the character of spirality have taken place in certain regions, and are still taking place. While the elementary change from one form of coil to another is a sudden mutation when the relation of a single parent to its young is concerned, the collective result is a slow alteration like a wave, spreading from one colony to another and from one area to others. That the factors of such changes are congenital is virtually self-evident. There is no evidence of alteration in places like Vaianai, Haapiti and Oio, and Vaiana; if there were effective external influences at work, the problem would remain as to why certain individuals respond while others do not. Where *young of both kinds* are borne by a single parent, no doubt can possibly arise regarding the internal causation of their manifest differences.

Before proceeding to the biometrical data, some aspects of variation in structural qualities may be briefly discussed. What may be called normal shells are found which are, nevertheless, far from the average of their fellows in one or another feature. Very short examples entitled to be called dwarfs occur sporadic-

ally in colonies of large shells, or they may be merely the smallest members of a continuous array, as in the *strigosa* examples of plate 21, figures 33 and 47. At the opposite extreme we find excessively long shells, like the extraordinary giants discovered in Oio and in Urufara (plate 20, figs. 31 and 32), separated by a notable interval from the largest of their associates. The gigantic type of aberration was found in only a single case in Tahiti.

The proportion of the whole shell also varies greatly. The stoutest has an index of 64 per cent (plate 21, fig. 24), while the most slender shell is 46 per cent. It must not be taken for granted that short shells are generally stout and long shells slender, for illustrations could be given of long and broad specimens as well as short and slender examples. The aperture varies in some correlation with the entire shell but not in strict correspondence. The lowest figure for the proportions of the aperture is 65 per cent (plate 20, fig. 33) while the highest is 88 per cent (plate 20, fig. 34). Considerable variation occurs also in the proportions of the aperture and shell as regards length, again without strict correspondence with other features; the figures run from 43 per cent (plate 21, fig. 23) to 60 per cent (plate 20, fig. 35).

Another category of variants includes shells which can not be called actually normal, such as a specimen with a contracted terminal segment of the last whorl (plate 20, figs. 46, 47), while another specimen may have the opposite character of an inflated terminal whorl. Sometimes true teratology occurs when an adolescent has suffered an injury and forms its later whorls abnormally; the accident may have occurred in very early youth (plate 20, fig. 45). Finally the lip may be abnormally completed (plate 20, fig. 44). Ninety-two instances of the last are recorded out of 14,600 adults. Seven occurred among about 400 adults taken in Maraarii Valley in 1923, and such a large relative number suggests that possibly the "abnormality" in question may be a normal one in heredity; certainly the possibility is not excluded.

Because *P. suturalis vexillum* is very wide-spread throughout Moorea, the biometric data are voluminous; they define the several series taken in various years in the many localities in terms of the ranges, mean values and standard deviations of the seven characters (tables 74-81). As such, they constitute a definite description of the components of the species from which relatively sure conclusions may be drawn. Clearly it is not practicable to review verbally all the facts that are presented in the statistical tables, however profitable that might be; for the most part the figures must speak for themselves. Only certain illustrative facts will be reviewed for the sake of their own significance and of their representative value. In view of the extensive territory held by *vexillum*, the several associations must be dealt with in subordinate groupings defined in geographical terms. Much would be gained if it were practicable to consider the colonial qualities of coloration at the same time, but these must be relegated to a subsequent section.

ATIMAHA TO PAFATU VALLEYS (tables 74–76)

These areas are clearly defined members of the outer circle extending from the southernmost point of the island, where the territories of *vexillum* and *strigosa* come in contact, to the extreme northern and western points inhabited by *suturalis*

and other species. The valley of Vaianai lies within this sector and its forms of today are of particular interest on account of the longer occupation of this region by *suturalis*. The data relating to the associations of this sector are given in tables 74 to 76.

The Atimaha colonies are exclusively dextral. Ignoring the small series of 1919, apparently some diminution in the absolute measures took place in the interval between 1907 and 1923, with negligible changes in the proportionate measures. The Paahonu shells are interesting only on account of their departure from the neighboring colonies on either side.

Colonial change with the passage of the years is clearly indicated by the data for the Vaianai associations; the length of the shell decreased from 1907 to 1919 and then increased to 1923, to an extent which brings the absolute figures to higher values than those of the earliest year. Some of the proportionate measures differ markedly.

The shells of the dextral series from Oio are larger than those of Vaianai. The figures do not disclose definite changes with the passage of time as do those of the foregoing series. The vanished group of sinistral shells found in 1907 comprises smaller and stouter individuals than the dextral associates; and the same relation obtains in the case of the reversed component of the Haapiti colony of 1907, likewise without descendants today.

Uufau Valley is the locality where both kinds of snails are abundantly present. Comparing the series of 1907 and 1923, a general reduction of the absolute measures has taken place consistently, and the shell and aperture have become relatively wider. Comparing the dextral and sinistral components, the latter are noticeably shorter in both series, but the other dimensions such as those of the aperture are not uniformly diminished in correspondence.

The shells of the Moruu colony are smaller than those of Uufau, and again a general shortening seems to have taken place with the passage of a few years. From this point northward, the colonies become larger with some regularity, and the longest shells of the entire sector appear in the extreme valley of Pafatu. This is a very interesting result in connection with the assumption of environmental effects, because the ultimate valley is more open, it supports more sparse vegetation, and it is less moist on account of freer underground drainage. The supposition that only the more vigorous animals of larger growth can survive under such conditions is not borne out by the facts; the range of variation runs down to low figures, while conversely equally large individuls are to be found in Uufau and elsewhere within the more favorable territory.

MARAMU TO FAATOAI VALLEYS (tables 77–79)

We now cross the crescent of mountains to the inner series of colonies which are to be followed from the central point of Maramu through the western part of the Opunohu basin to the extreme area of Faatoai. Maramu articulates geographically with Vaianai, but the *vexillum* shells are much larger in the former; they are also relatively large in all the valleys as far as Vairahi, where they become reduced to the semblance of the Uufau colonies, just across the divide. In contrast with

these structural affinities, the Morioahu series are more like those of Uufau than are the collections from the Vairahi area, as regards the proportions of dextral and sinistral components. As the several representative series were not taken in exactly the same areas of forest in the Vairahi region, annual changes are not necessarily to be inferred from the statistical differences. The Tupuna and Vaiana colonies are made up of larger shells than are found in Vairahi, and consequently are more like those of Faataofe and Fanautaata, across the lowlands.

The survey then crosses the ridges to the small interpolated sector of Aareo, to the larger valley of Urufara, and then to the greater basin of Faatoai. In general, the *vexillum* shells are large and well developed, but more slender than usual in the proportions of the whole shell. The length of the aperture is relatively less than in the colonies of the outer range, *i.e.* Atimaha to Pafatu.

TEFEO TO PAPAROA VALLEYS (table 80)

Returning to Maramu, we review the colonies of the inner array that lie to the east and northeast. The material was secured almost entirely during the later years of study and there are no definite annual comparisons to be made. The shells are large, wide and slender, and at times attain dimensions which rival those of *P. tohiveana* in some respects. There is nothing in the environment to account for their distinctions, and their associates of other species do not display similar enlargements. There are no sinistral components anywhere in this array of valleys, although *P. mooreana* flourishes in Tefeo Valley and *P. tohiveana* in Fareaito Valley.

VAIARE TO MAHAREPA VALLEYS (table 81)

Here we again cross the main ridge of mountains to the outer zone, passing around the territory occupied by *P. suturalis strigosa*. The snails are unmistakably *vexillum* in Vaiare, and all of the subordinate areas bear sinistral as well as dextral representatives. The Puutu shells are generally smaller than those of Vaipohe, and the animals of Faamaariri are also smaller than those of the central subdivision. Apparently the streams of migration have been somewhat independent as they flowed downward from the pass at the head of the valley. Yet the probability of individual colonial differentiation is suggested by the diverse relations of the reversed and dextral components in Puutu, when the 1907 series is compared with that of 1919, and by the 1924 series of Faamaariri when that is contrasted with the other series from that subdivision.

The animals of Tepu and Maharepa are exclusively sinistral, and their shells are slightly smaller than those of the Vaiare series. The relation here is therefore opposite to that obtaining in the extreme area of Faatoai to the northwest, where the animals were larger.

The foregoing brief survey takes into account only a few of the available data, but it strengthens the conviction that external circumstances are without power to mold the shells of the animals and that the patent variations exhibited by the several colonies are controlled by innate factors. The result is the same as in the case of the direction of the coil.

The parietal tooth attains various degrees of development in the several colonies (tables 82–85). In the series of associations from Atimaha to Pafatu this structure is in evidence in almost all of the shells and the colonial averages run high. It is also well marked in the series from Maramu to Faatoai, but in sharp contrast it is weakly developed in the large-shelled associations from Tefeo to Paparoa. The Puutu and Faamaariri series show a greater development of the tooth than do those from Vaipohe—another indication of somewhat independent migration into the Vaiare sector. The Tepu and Maharepa colonies are not distinctive.

PARTULA SUTURALIS VEXILLUM Pease—COLOR CHARACTERS

The characters of coloration are quite independent of those considered in the previous section, namely spirality and statistical definition. They are well worthy of study on their own merits and they gain additional value from their demonstration of identical principles of variation and distribution throughout the wide territory occupied by *suturalis*.

The present species has existed so long that an advanced condition of diversification has been attained. Taking the species as a whole, the number of color-classes proves to be greater than in any other, not excepting *P. tæniata*, although the latter is more differentiated in structural respects. Many of these color classes must be further subdivided into color-orders, with local modes of occurrence. And with an abundance of material in hand, even the color orders can be analyzed into lesser components.

In correlation with the wide distribution of the species, the distinguishable colonies vary considerably in color composition, as they do in biometric characters and in spirality. Indeed, the many colonial combinations of color classes are somewhat bewildering in their variety, and because their relative numbers are also diverse, a second kind of colonial differentiation is added to the first. In the third place, such color classes as are present display very different relations to one another in their statistical characters. The whole situation is quite satisfactory as regards the wealth of available material, but its complexity makes it impossible to do justice to the facts without a somewhat extensive description, and frequent recourse to the census tables (tables 10–14).

We must begin with the records in the literature which naturally include references to the colors of the type specimens, and the variety *vexillum* takes precedence. In Pfeiffer's original description, a transversely streaked example was cited as the type, which in the present study is distinguished as **strigata**. Pease's description of *P. vexillum* related to a characteristic shell with two revolving bands; as *vexillum* is to be used as applying to a primary variety, the name **frenata** is employed for this color variety. Pease also notes a single dark "reddish-chestnut" specimen, which exemplifies the class herein called **atra**. Garrett's list begins with **frenata** as the true type in the sense that it is the most prevalent; he then enumerates **atra** as rare, **strigata** as common, and certain other "rare" types which are herein called **bisecta** and **zonata**. Passing to the primary variety *strigosa*, again an unfasciated type of coloration is described, although banded shells are greatly in the

majority; the real basis for the varietal distinction is structural, however different the collective modes of coloration may be. Garrett gives some very important comments on the color characters of *strigosa*, noting the occurrence of the same kinds as in *vexillum*, the greater abundance of **atra**, the rare presence of a light type here called **apex**, and the prevalence of the kind with one band, **cingulata**, which in my experience is not found in colonies of *vexillum*. He also cites the peculiar and prominent transverse streaks of a *light* color which give "a somewhat tesselated appearance" to some of the *strigosa* shells; like the **cingulata** pattern, this form of coloration is not displayed by any component of a *vexillum* colony.

It is necessary to deal separately with *vexillum* and *strigosa*, and in each case to take up first the distinguishable color classes without full reference to the facts of their variable distribution. Then the several colonies will be reviewed, and the significance of their differences in area and in time can be considered with profit.

Beginning with the lightest type, we find a well-demarcated class called **apex** (plate 20, figs. 17-21) in which the general ground-color is yellowish corneous and the youngest whorls are more or less extensively tinged with brown. Very fine brown lines running transversely are visible under the lens and sometimes macroscopically, but they fall far short of the bold markings displayed by the next class. The local occurrence of **apex** is noteworthy and will be discussed later.

The shell of Pfeiffer's original description represents a more abundant type, **strigata** (plate 20, figs. 22-31), but its class is always exceeded in numbers by **frenata**, except in the single valley of Haapiti. The general background is corneous brown, and the transverse streaks of deeper brown range from narrow to wide; the whole shell may therefore be very light, seemingly not far removed from **apex** (plate 20, fig. 22), or very dark at the opposite extreme (plate 20, fig. 30). As the contrast between the ground-color and that of the cross-markings varies, the peculiar streaked appearance may be weak or very boldly displayed (plate 20, fig. 26). Some of the shells in Vaianai have the basal area more or less suffused with brown, and more heavily at the upper borders of this area (plate 20, fig. 30); such shells simulate some of the fasciated types, but their transverse streaks place them in the present class. Where **strigata** occurs in valleys of the inner circle, notably Faataofe, and in the Vaiare region, the markings are firm and dark (plate 20, figs. 28, 29) and the whole color of the shell approaches the deep chestnut condition of a class called **castanea** in other species, though it never quite attains such a condition. The lip is sometimes tinged with color (plate 20, fig. 30).

We now come to the fasciated class, **frenata**, which forms by far the greater part of the population throughout the entire island, in every valley except Haapiti (plate 20, figs. 32-50). The shell is brown in ground-color, of lighter or darker hue. Usually there are fine transverse lines of brown, but they never gain the strength and boldness of the characteristic streaks of **strigata**. Two brown revolving bands constitute the distinctive features of the class.

Within the limits of the whole class as thus defined, variations occur in considerable variety; at times a modification of the **frenata** pattern is displayed by so

TABLE 10—*Partula suturalis vexillum. Atimaha to Pafatu Valleys. Census of the color classes*

Series	Year	Total	Dextral									Sinistral						
			All	apex	strigata	frenata	cestata	zonata	bisecta	atra	sub-zonata	All	strigata	frenata	cestata	zonata	bisecta	atra
Atimaha	1907	103	103	.....	.....	91	1	4	5	1	1	.....	.....	.....	.....	.....	.....	.....
Atimaha	1919	5	5	.....	.....	3	.....	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....
Atimaha	1923	174	174	.....	.....	155	.....	1	16	1	1	.....	.....	.....	.....	.....	.....	.....
Paahonu	1919	39	39	.....	.....	33	.....	2	4	.....	.....	.....	.....	.....	.....	.....	.....	.....
Vaianai	1907	271	271	.....	2	255	.....	.....	13	1	.....	.....	.....	.....	.....	.....	.....	.....
Vaianai	1919	37	37	.....	.....	35	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....
Vaianai	1923	98	98	.....	5	78	.....	.....	14	1	.....	.....	.....	.....	.....	.....	.....	.....
Oio	1919	612	604	.....	26	556	.....	.....	20	2	.....	8	3	5	.....	.....	.....	.....
Oio	1923	158	158	.....	1	153	.....	.....	4	.....	.....	.....	.....	.....	.....	.....	.....	.....
Haapiti	1907	241	223	.....	109	96	.....	8	3	7	.....	18	7	10	.....	.....	1	.....
Haapiti	1923	266	266	14	124	109	.....	5	4	10	.....	.....	(adol.)	.....	.....	.....	.....	.....
Uufau	1907	303	38	.....	7	30	.....	.....	.....	1	.....	265	33	228	.....	3	1	.....
Uufau	1923	533	156	.....	22	128	2	1	1	2	.....	377	75	294	.....	2	2	4
Moruu	1909	127	.....	.....	.....	.....	.....	.....	.....	.....	.....	127	3	117	.....	7	.....	.....
Moruu	1923	410	1	.....	.....	1	.....	.....	.....	.....	.....	409	12	383	1	13	.....	(adol.)
Varari	1909	227	.....	.....	.....	.....	.....	.....	.....	.....	.....	227	20	134	10	26	6	31
Varari	1923	351	.....	.....	.....	.....	.....	.....	.....	.....	.....	351	29	242	6	32	8	34
Maraarii	1907	389	(emb.)	.....	.....	.....	.....	.....	.....	.....	.....	389	67	197	.....	26	6	93
Maraarii	1923	399	.....	.....	.....	.....	.....	.....	.....	.....	.....	399	24	246	6	18	24	81
Maatepua	1924	7	.....	.....	.....	.....	.....	.....	.....	.....	.....	7	.....	7	.....	.....	.....	.....
Taapurau	1923	36	.....	.....	.....	.....	.....	.....	.....	.....	.....	36	5	29	.....	(adol.)	(adol.)	2
Taapurau	1924	131	.....	.....	.....	.....	.....	.....	.....	.....	.....	131	8	122	.....	1	.....	(adol.)
Pafatu	1907	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	1	.....	.....	.....	.....
Pafatu	1919	9	.....	.....	.....	.....	.....	.....	.....	.....	.....	9	.....	8	.....	1	.....	.....
Summary	....	4,927	2,173	14	296	1,723	3	22	87	26	2	2,754	286	2,023	23	128	48	246

TABLE 10—*Continued*

Per cent

Atimaha..	1907	.....	100	.....	.....	88.35	0.97	3.88	4.85	0.97	0.97	.....	.....	.....	.....	.....	.....	.....
Atimaha..	1919	.....	100	.....	.....	60.0	.....	20.0	20.0	.....	.....	.....	.....	.....	.....	.....	.....	.....
Atimaha..	1923	.....	100	.....	.....	89.08	.....	0.57	9.19	0.57	0.57	.....	.....	.....	.....	.....	.....	.....
Paahonu..	1919	.....	100	.....	.....	84.62	.....	5.12	10.25	.....	.....	.....	.....	.....	.....	.....	.....	.....
Vaianai...	1907	.....	100	.....	0.74	94.09	.....	.....	4.80	0.37	.....	.....	.....	.....	.....	.....	.....	.....
Vaianai...	1919	.....	100	.....	.....	94.59	.....	.....	5.41	.....	.....	.....	.....	.....	.....	.....	.....	.....
Vaianai...	1923	.....	100	.....	5.10	79.59	.....	.....	14.28	1.02	.....	.....	.....	.....	.....	.....	.....	.....
Oio.....	1919	.....	98.69	.....	4.25	90.85	.....	.....	3.27	0.32	.....	1.31	0.49	0.82	.....	.....	.....	.....
Oio.....	1923	.....	100	.....	0.63	96.83	.....	.....	2.53	.....	.....	.....	.....	.....	.....	.....	.....	.....
Haapiti...	1907	.....	92.53	.....	45.24	39.83	.....	2.32	1.24	2.90	.....	7.47	2.90	4.15	.....	.....	0.41	.....
Haapiti...	1923	.....	100	5.26	46.62	40.98	.....	1.88	1.50	3.76	.....	.....	.....	.....	.....	.....	.....	.....
Uufau....	1907	.....	12.54	.....	2.31	9.90	.....	.....	.....	0.33	.....	87.46	10.89	75.25	.....	0.99	0.33	.....
Uufau....	1923	.....	29.27	.....	4.13	24.01	0.37	0.19	0.19	0.37	.....	70.73	14.08	55.16	.....	0.37	0.37	0.75
Moruu....	1909	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	100	2.36	92.12	.....	5.51	.....	.....
Moruu....	1923	.....	0.24	.....	.....	0.24	.....	.....	.....	.....	.....	99.75	2.92	93.41	0.24	3.17	.....	.....
Varari....	1909	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	100	8.81	59.03	4.40	11.01	2.64	14.10
Varari....	1923	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	100	8.26	68.94	1.71	9.12	2.28	9.69
Maraarii..	1907	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	100	17.22	50.64	.....	6.68	1.54	23.91
Maraarii..	1923	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	100	6.01	61.65	1.50	4.51	6.01	20.30
Maatepua.	1924	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	100	.....	100	.....	.....	.....	.....
Taapurau.	1923	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	100	13.89	80.55	.....	.....	.....	5.55
Taapurau.	1924	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	100	6.11	93.13	.....	0.76	.....	.....
Pafatu....	1907	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	100	.....	100	.....	.....	.....	.....
Pafatu....	1923	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	100	.....	88.89	.....	11.11	.....	.....
Summary.	.....	.....	44.103	0.284	6.005	34.970	0.061	0.446	1.766	0.528	0.040	55.896	5.805	41.059	0.467	2.598	0.974	4.993

TABLE 11—*Partula suturalis vexillum. Maramu to Faatoai Valleys. Census of the color classes*

Series	Year	Total	Dextral								Sinistral					
			All	apex	strigata	frenata	cestata	zonata	bisecta	atra	All	strigata	frenata	zonata	bisecta	atra
Maramu	1919	93	93	.....	.....	93	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Maramu	1923	28	28	.....	.....	22	.....	.....	6	.....	.....	.....	.....	.....	.....	.....
Maramu	1924	67	67	.....	.....	57	.....	.....	10	(adol.)	.....	.....	.....	.....	.....	.....
Mouarua	1924	88	88	.....	8	33	.....	3	27	17	.....	.....	.....	.....	.....	.....
Faataofe	1923	167	167	.....	5	78	.....	4	49	31	.....	.....	.....	.....	.....	.....
Faataofe	1924	217	217	2	12	78	.....	3	68	54	.....	.....	.....	.....	.....	.....
Fanautaata	1923	174	174	.....	6	131	.....	9	22	6	.....	.....	.....	.....	.....	.....
Roroie	1923	320	320	.....	21	142	1	7	67	82	.....	.....	.....	.....	.....	.....
Morioahu east	1923	191	79	.....	1	68	.....	.....	6	4	112	2	104	3	3	.....
Morioahu	1923	461	106	.....	1	100	.....	3	2	.....	355	2	342	10	1	.....
Opunohu west	1907	149	4	.....	.....	4	.....	.....	.....	.....	145	.....	142	.....	3	.....
Opunohu west	1909	94	.....	.....	.....	.....	.....	.....	.....	.....	94	.....	92	.....	2	(adol.)
Opunohu west, below pass	1919	84	7	.....	.....	7	.....	.....	.....	.....	77	.....	71	3	3	.....
Opunohu west, below pass	1923	191	3	.....	.....	3	.....	.....	.....	.....	188	.....	182	1	5	.....
Opunohu west, below Atiati	1923	372	1	.....	.....	1	.....	.....	.....	.....	371	.....	317	8	44	2
Opunohu west, Vairahi	1924	161	.....	.....	.....	.....	.....	.....	.....	.....	161	.....	152	.....	9	.....
Tupuna	1923	173	.....	.....	.....	(adol.)	.....	.....	.....	.....	173	.....	171	.....	2	.....
Vaiana	1923	77	1	.....	.....	1	.....	.....	.....	.....	76	.....	73	.....	3	.....
Aareo	1909	1	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	1	.....	.....	.....
Aareo	1919	2	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	2	.....	.....	.....
Aareo	1923	9	.....	.....	.....	.....	.....	.....	.....	.....	9	.....	9	.....	.....	.....
Urufara	1907	10	.....	.....	.....	.....	.....	.....	.....	.....	10	(adol.)	10	.....	.....	.....
Urufara	1909	20	.....	.....	.....	.....	.....	.....	.....	.....	20	.....	19	.....	1	.....
Urufara south (A)	1923	12	.....	.....	.....	.....	.....	.....	.....	.....	12	.....	12	.....	.....	.....
Urufara south (B)	1923	1	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	1	.....	.....	.....
Urufara south (C)	1923	48	.....	.....	.....	.....	.....	.....	.....	.....	48	.....	36	.....	12	.....
Urufara north central	1924	60	.....	.....	.....	.....	.....	.....	.....	.....	60	6	54	.....	.....	.....
Faatoai	1909	16	.....	.....	.....	.....	.....	.....	.....	.....	16	.....	16	.....	.....	.....
Faatoai	1919	59	.....	.....	.....	.....	.....	.....	.....	.....	59	.....	56	3	.....	.....
Faatoai, Mave	1923–1924	24	.....	.....	.....	.....	.....	.....	.....	.....	24	7	17	.....	.....	.....
Faatoai, upper Mave	1923	14	.....	.....	.....	.....	.....	.....	.....	.....	14	5	9	.....	.....	.....
Faatoai, Taatuapæ	1923	17	.....	.....	.....	.....	.....	.....	.....	.....	17	.....	17	.....	.....	.....
Faatoai, Vaipapa	1924	15	.....	.....	.....	.....	.....	.....	.....	.....	15	2	13	(adol.)	.....	.....
Faatoai, Terahimaue	1923	7	.....	.....	.....	.....	.....	.....	.....	.....	7	.....	7	(adol.)	.....	.....
Faatoai, Mataitau	1923	5	.....	.....	.....	.....	.....	.....	.....	.....	5	.....	5	.....	.....	.....
Summary:																
Maramu to Vaiana		3,107	1,355	2	54	818	1	29	257	194	1,752	4	1,646	25	75	2
Aareo to Faatoai		320	.....	.....	.....	.....	.....	.....	.....	.....	320	20	284	3	13	.....
Whole series		3,427	1,355	2	54	818	1	29	257	194	2,072	24	1,930	28	88	2

TABLE 11—*Continued*

		Per cent													
Maramu	1919	100			100										
Maramu	1923	100			78.57			21.43							
Maramu	1924	100			85.07			24.92							
Muuaroa	1924	100		9.09	37.50		3.41	30.68	19.32						
Faataofe	1923	100		2.99	46.71		2.39	29.34	18.56						
Faataofe	1924	100	0.92	5.53	35.94	1	1.38	31.34	24.88						
Fanautuata	1923	100		3.45	75.29		5.17	12.64	3.45						
Roroie	1923	100		6.56	44.37	0.31	2.19	20.94	25.62						
Morioahu east	1923	41.36		0.52	35.60			3.14	2.10	58.64	1.05	54.55	1.57	1.57	
Morioahu	1923	23.00		0.22	21.69		0.65	0.43		77.00	0.43	74.18	2.17	0.22	
Opunohu west	1907	2.68			2.68					97.31		95.30		2.01	
Opunohu west	1909									100		97.87		2.13	
Opunohu west, below pass	1919	8.33			8.33					91.66		84.52	3.57	3.57	
Opunohu west, below pass	1923	1.57			1.57					98.43		95.29	0.52	2.62	
Opunohu west, below Atiati	1923	0.27			0.27					99.73		85.21	2.15	11.83	0.54
Opunohu west, Vairahi	1924									100		94.41		5.59	
Tupuna	1923									100		98.84		1.16	
Vaiana	1923	1.39			1.29					98.70		94.80		3.90	
Aareo	1909									100		100			
Aareo	1919									100		100			
Aareo	1923									100		100			
Urufara	1907									100		100			
Urufara	1909									100		100			
Urufara south (A)	1923									100		95.00		5.00	
Urufara south (B)	1923									100		100			
Urufara south (C)	1923									100		75.00		25.00	
Urufara north central	1924									100	10.00	90.00			
Faatoai	1909									100		100			
Faatoai	1919									100		94.91	5.08		
Faatoai, Mave	1923 1924									100	29.17	70.83			
Faatoai, upper Mave	1923									100	35.71	64.28			
Faatoai, Taatuapæ	1923									100		100			
Faatoai, Vaipapa	1924									100	13.33	86.67			
Faatoai, Terahimaue	1923									100		100			
Faatoai, Mataitau	1923									100		100			
Summary:															
Maramu to Vaiana		43.611	0.064	1.738	26.328	0.032	0.933	8.272	6.244	56.388	0.129	52.977	0.804	2.414	0.064
Aareo to Faatoai										100	6.250	88.750	0.940	4.060	
Whole series		39.539	0.058	1.576	23.869	0.029	0.846	7.499	5.661	60.461	0.700	56.317	0.817	2.568	0.058

TABLE 12—*Partula suturalis vexillum. Tefeo to Paparoa Valleys. Census of the color classes*

Series	Year	Dextral							Sinistral
		All	apex	strigata	frenata	zonata	bisecta	atra	
Tefeo	1923	42	.....	.....	42	.....	.....	.....	.....
Tefeo east	1923	53	15	1	35	1	1	(adol.)	.....
Fareaito	1923	177	.....	6	130	.....	35	6	.....
Fareaito	1924	36	.....	3	8	1	15	9	.....
Irua	1919	6	.....	.....	6	.....	.....	.....	.....
Irua	1923	49	1	.....	43	.....	4	1	.....
Ririofau	1924	59	.....	.....	51	.....	7	1	.....
Poua	1919	62	.....	.....	62	.....	.....	.....	.....
Poua	1923	53	.....	.....	40	.....	12	1	.....
Mouaputa (A)	1919	136	.....	.....	117	2	15	2	.....
Mouaputa (B)	1919	218	.....	.....	188	2	25	3	.....
Mouaputa	1923	190	.....	2	147	5	31	5	.....
Paparoa	1909	2	.....	.....	2	.....	.....	.....	.....
Whole series	.....	1,083	16	12	871	11	145	28	.....
		Per cent							
Tefeo	1923	100	.....	.....	100	.....	.....	.....	.....
Tefeo east	1923	100	28.30	1.88	66.04	1.88	1.88	.....	.....
Fareaito	1923	100	.....	3.38	73.45	.....	19.77	3.38	.....
Fareaito	1924	100	.....	8.33	22.22	2.78	41.67	25.00	.....
Irua	1919	100	.....	.....	100	.....	.....	.....	.....
Irua	1923	100	2.04	.....	87.75	.....	8.16	2.04	.....
Ririofau	1924	100	.....	.....	86.44	.....	11.86	1.69	.....
Poua	1919	100	.....	.....	100	.....	.....	.....	.....
Poua	1923	100	.....	.....	75.47	.....	22.64	1.88	.....
Mouaputa (A)	1919	100	.....	.....	86.03	1.47	11.03	1.47	.....
Mouaputa (B)	1919	100	.....	.....	86.24	0.92	11.47	1.37	.....
Mouaputa	1923	100	.....	1.05	77.36	2.63	16.32	2.63	.....
Paparoa	1909	100	.....	.....	100	.....	.....	.....	.....
Whole series	.....	100	1.477	1.108	80.425	1.016	13.389	2.585	.....

many individuals that the institution of a color order is justified. In the first place, the two characteristic bands may be approximately equal in value and relatively broad (plate 20, figs. 33, 36, 37) or relatively narrow (plate 20, fig. 38). Far more frequently, however, the upper band is weaker than the lower (plate 20, fig. 34). Although the shell illustrated is greatly outnumbered by the illustrated variants from the sub-type, it must be emphasized that it presents the usual condition throughout the island. The extreme of this disparity is reached in cases where the upper band is actually evanescent on the body-whorl (plate 20, fig. 40). The lower band is rarely split and attenuated at its lower limit (plate 20, fig. 41). Quite independently, the primary bands vary in their spacing; the shells of figures 41 and 43, plate 20, are extremes in the wide separation of the stripes.

TABLE 13—*Partula suturalis vexillum. Vaiare to Maharepa Valleys. Census of the color classes*

Series	Year	Total	Dextral									Sinistral								
			All	apex	strigata	frenata	unilineata	cestata	bisecta	bisecta lata	atra	All	apex	strigata	frenata	unilineata	cestata	zonata	bisecta	atra
Vaiare-Puutu	1907	80	62			62						18			18					
Vaiare-Puutu	1919	151	104	19	1	83	(adol.)			1		47	10		37					
Vaiare-Vaipohe	1919	6	5			4			1			1			1					
Vaiare-Vaipohe	1924	167	164			130			31		3	3			3					(adol.)
Vaiare-Faamaariri	1919	240	154	27		124	3	(adol.)				86	25	1	58	2				(adol.)
Vaiare-Faamaariri (A)	1923	148	79	9	(adol.)	69	1					69	2	12	52	1	2			
Vaiare-Faamaariri (B)	1923	275	132	12		120	(adol.)					143	29		114					
Vaiare-Faamaariri	1924	200	172	5		128	32	(adol.)	7			28	2		18	5		1	2	
Tepu	1919	22										22			19		3			
Maharepa	1923	79										79		5	69	5				
Whole series		1,368	872	72	1	720	36		39	1	3	496	68	18	389	13	5	1	2	
Per cent																				
Vaiare-Puutu	1907		77.50			77.50						22.50			22.50					
Vaiare-Puutu	1919		68.87	12.58	0.66	54.97				0.66		31.12	6.62		24.50					
Vaiare-Vaipohe	1919		83.33			66.66			16.66			16.66			16.66					
Vaiare-Vaipohe	1924		98.20			77.84			18.56		1.79	1.79			1.79					
Vaiare-Faamaariri	1919		64.16	11.25		51.66	1.25					35.83	10.42	0.41	24.17	0.83				
Vaiare-Faamaariri (A)	1923		53.38	6.08		46.61	0.68					46.61	1.35	8.11	35.11	0.68	1.35			
Vaiare-Faamaariri (B)	1923		48.00	4.36		43.64						52.00	10.55		41.45					
Vaiare-Faamaariri	1924		86.00	2.50		64.00	16.00		3.50			14.00	1.00		9.00	2.50		0.50	1.00	
Tepu	1919											100			86.36		13.64			
Maharepa	1923											100		6.33	87.34	6.33				
Whole series			63,743	5.263	0.073	52.632	2.631		2.851	0.073	0.220	36.257	4.971	1.316	28.435	0.950	0.366	0.073	0.146	

TABLE 14—*Partula suturalis vexillum. Summary census of the color classes*

Series	No.	Dextral									Sinistral							
		apex	strigata	frenata	unilineata	cestata	zonata	bisecta	atra	subzonata	apex	strigata	frenata	unilineata	castata	zonata	bisecta	atra
Atimaha-Pafatu	4,927	14	296	1,723	.....	3	22	87	26	2	.....	286	2,023	.....	23	128	48	246
Maramu-Faatoai	3,427	2	54	818	.....	1	29	257	194	.....	.....	24	1,930	.....	.....	28	88	2
Tefeo-Paparoa	1,083	16	12	871	.....	.....	11	145	28	.....	.....	.....	.....	.....	.....	.....	.....	.....
Vaiare-Maharepa	1,368	72	1	720	36	.....	.....	40	3	.....	68	18	389	13	5	1	2	.....
Vexillum, all	10,805	104	363	4,132	36	4	62	529	251	2	68	328	4,342	13	28	157	138	248
Per cent																		
Atimaha-Pafatu	.....	0.284	6.008	34.970	.....	0.061	0.446	1.766	0.528	0.040	.....	5.805	41.059	.....	0.467	2.598	0.974	4.993
Maramu-Faatoai	.....	0.058	1.576	23.869	.....	0.029	0.846	7.499	5.661	.....	.....	0.700	56.317	.....	.....	0.817	2.568	0.058
Tefeo-Paparoa	.....	1.477	1.108	80.425	.....	.....	1.016	13.389	2.585	.....	.....	.....	.....	.....	.....	.....	.....	.....
Vaiare-Maharepa	.....	5.263	0.073	52.632	2.631	.....	.....	2.924	0.220	.....	4.971	1.316	28.435	0.950	0.366	0.073	0.146	.....
Vexillum, all	.....	0.962	3.359	38.241	0.333	0.037	0.574	4.896	2.323	0.018	0.692	3.035	40.185	0.120	0.259	1.453	1.277	2.295

Other variants are characterized by revolving bands or zones of color in addition to the two primary features, and these are respectively basal and sutural in location. In many valleys of the outer circle from Oio onward, the basal color is prevalent; and when the principal bands become reduced or extinguished, this alone is shown (plate 20, figs. 48, 49); the result is a color order to be called **frenata basalis.** Sutural color is rare (plate 20, figs. 43, 50), and still more rarely is it developed along with the basal zone in the absence or reduction of the primary bands; the result is a very peculiar variant (plate 20, fig. 49). From the study of adolescent and embryonic shells, it appears that the distinctive pattern is established by resolution of an early uniform brown coloration. The time when resolution takes place may be relatively early (plate 20, fig. 43) or much later (plate 20, fig. 37).

While the examples with some disparity of the primary bands are present sporadically in several colonies, where they intergrade with the basic type, such shells constitute a definite group in Vaiare, and almost exclusively in the Faamaariri division of that valley. They are distinguished as **unilineata** (plate 20, fig. 51; plate 21, figs. 1, 2). The ground-color is light as in the **apex** of this territory and it is not at all that of the associated **frenata.** The single band is more intense on the spire and it usually loses strength on the body-whorl; in this respect it resembles the stripe of the **cestata** type of *P. olympia.* While the class may be a derivative of **frenata** parentage, it may be affiliated with the **apex** class with equal justice. Although its single band seems to ally it with the **cingulata** pattern as found in *P. dendroica* and *P. suturalis strigosa,* this band is not situated in the median line as in the other cases.

The class called **cestata** (plate 21, figs. 3-7) is represented in the colonies from Uufau to Maraarii inclusive, but it is very rare otherwise. A revolving band encircles the entire shell in the median line. This band occupies the same space as the clear area between the two bands of the **frenata** type, in which respect the **cestata** class differs from the one to be considerd next in sequence. When the ground-color is light, the appearance of the shell is strikingly beautiful (plate 21, fig. 3). The ground color may be darker (plate 21, fig. 4), and in one case only it was very deep indeed, approaching that of **atra** (plate 21, fig. 6). As in **frenata,** the subsidiary zones of color near the suture and at the base may also be displayed (plate 21, fig. 7), but they are sufficiently independent to warrant the view that their manifestation is a separate genetic phenomenon.

Greater numbers of strongly fasciated shells constitute the **zonata** class (plate 21, figs. 8-14), although they are very local in their occurrence. In contrast with the foregoing, the broad girdle of color includes the two bands of the **frenata** pattern. Sutural and basal colorings (plate 21, figs. 9, 10) are more frequently displayed than in **cestata,** and in extreme cases (plate 21, fig. 11) there are only narrow strips of the ground-color still visible. In *P. mirabilis* the corresponding class was made up largely of shells like the last mentioned. Like the **frenata** shells, the younger individuals of the **zonata** class are deeply and uniformly colored as a rule. Later the pattern appears by differentiation of the various areas. It is not surprising that some shells display a transitional condition from **zonata** to **frenata** (plate 21, fig. 14), for the two modes are clearly related.

Two adult shells of a related kind were found in Atimaha, one in 1907 and the other in 1923, together with an adolescent of the same nature. The pattern is called **subzonata** (plate 21, figs. 15, 16), for it is like that of heavily colored examples of the preceding class with the upper light stripe obliterated. The specimens in question might be treated as variants of **zonata** were it not for the fact that a similar form of coloration is definitely shown by certain shells of *P. mirabilis*, in such numbers as to mark it as a real type.

Another very striking form of coloration is especially interesting because it is the exact opposite of **cestata**. In this there is a median longitudinal area where only the ground-color is displayed, while deep color extends from this to the suture and to the base; on these accounts the class is named **bisecta** (plate 21, figs. 17-24). The ground-color may be lighter (plate 21, fig. 17) or darker (plate 23, fig. 18), as in **frenata**, while the lateral areas of deep color may be a warm brown (plate 21, fig. 19) or very intense (plate 21, figs. 17, 18, 20). Doubtless some of the shells assigned to this class are really the obverse of **zonata**, like the specimen of figure 21, plate 21; while the lateral zones of color of typical **bisecta** include the two bands of **frenata**, in the case illustrated it would seem that such bands are excluded. Ordinarily it is not feasible to assort the shells of the present class into two orders because the two bands of the **frenata** type are so variously spaced; but in Vaiare-Puutu a single shell appeared which is really different from the usual **bisecta**. Its like is more frequent in *strigosa*, and it seems worthy of special recognition. It is called **bisecta lata** (plate 21, fig. 22). Narrow bands of deep color lie near the suture and near the base. The shell simulates some of the **frenata** specimens distinguished as **basalis**; however it is not a modified **frenata** but something more nearly allied to ordinary **bisecta**.

At the last we come to the sharply contrasted type of shell named **atra**, in recognition of its intense pigmentation which actually approaches solid black (plate 21, figs. 25-30). The shells at the lighter end of the series are like those of the class called **phæa** in *P. aurantia* and *P. mirabilis*, but nowhere in the colonies of these two species are there any shells which approach the deep black specimens at the darker end of the scale in *suturalis*. When a white sutural area exists, as in a few specimens, the depth of the general color seems intensified. This whole class is one of the most striking to be found in any species of Moorea.

The next task is to survey the whole series of colonies of *suturalis vexillum* in order that their likenesses and differences in color composition may receive due attention. The comprehensive census of these colonies is given in tables 10 to 14.

The fundamental data define each association of *vexillum* in terms of the color components present and in terms of the relative frequencies of such components; hence near-by or distant colonies may be compared to ascertain whether any external circumstance can be held responsible for the differences that are displayed. Again, the facts are sufficiently definite for an enquiry into the reality of change in the color composition of a single colony with the lapse of years; in this connection also the question arises whether any demonstrable changes can be

correlated with some alteration in the external conditions. The general conclusion is that the responsible factors are congenital, exactly as in the case of structural qualities, dimensional and spiral.

Comment may be confined to only a few of the outstanding facts. The color class **frenata** is everywhere present, whether the snails are dextral or sinistral or of both kinds; it is the only class thus distributed, and it is the most abundant group in all valleys but one. The **strigata** pattern is found more abundantly in the outer range of valleys from Vaianai to Taapurau; in Haapiti it dominates all others. Elsewhere it is very occasional in valleys of the inner circle and in the extreme regions to the northeast and northwest. The **apex** type is even more sporadic in its occurrence, appearing in the Haapiti series of 1923, in the Faataofe series of 1924, more abundantly in Tefeo, and still more frequently in two of the subdivisions of Vaiare; it would be futile to seek external reasons for a distribution of such a nature.

Returning to the fasciated types, **bisecta** stands next to **frenata** as regards the number of localities where it exists and also as regards its numerical abundance. Yet valleys of identical nature and near to each other differ greatly. The peculiar aberration called **bisecta lata** was exhibited by only a single specimen from Vaiare-Puutu.

The broadly girdled forms called **zonata** are interrupted in their distribution. And the contrasted class **cestata** is even more sparsely represented in the whole array of localities, and its numbers are few where it does occur. The form **subzonata** was found only in Atimaha. The Vaiare region is the only one in which **unilineata** exists, and in some of the series the type is remarkably abundant.

The deeply colored shells constituting the class **atra** are especially interesting. They abound in the two large valleys of Varari and Maraarii on the outer coast, and are very numerous in the Faataofe region and in the neighborhood. Elsewhere they are irregular in their appearance.

Just as colonial changes in spirality with the passage of years have been demonstrated, so also the color constitution of several colonies seems to have altered. Garrett's comments on color composition undoubtedly referred to his ample series from Vaianai; he cites **frenata** as the type, denotes **strigata** as common, and adds that **atra**, **bisecta** and **zonata** are rare. In my own collections taken in Vaianai from 1907 to 1923, **strigata** and **atra** proved to be very rare, **bisecta** was more common, and **zonata** did not occur at all. Incidentally we may again note that sinistral components of the Vaianai colony of Garrett's time, with color characters like those of the dextral shells, had also entirely disappeared. It would seem that definite and real alterations had taken place in the genetic factors which are causal for the manifest qualities of the animals.

Other instances can be extracted from the tables. In Oio the **strigata** type exists in lesser numbers in the 1923 series than it did in the earlier collection of 1919. The Maraarii material is abundant for both the early year of 1907 and the later year of 1923, and consequently the differences in the proportions of the color classes may be relied upon as evidence of actual genetic change, notably in the reduction of the **strigata** class and in the increase of the **bisecta** class.

The complete statistical description of all the color classes of every local and annual series is far too voluminous to spread upon the record, as was done in the case of each of the preceding species. There are more than two score areas, and in many of these, *e.g.* Urufara, Vairahi and Vaiare, there are several local and annual series analyzed separately; the number of color groups in a single locality may run as high as sixteen when the dextral and sinistral representatives are assorted. The descriptive constants have actually been calculated and they are at hand in case similar analytical studies may be prosecuted at some future time. The great mass of fact is too significant to be passed over without some consideration, and a few tables are given (tables 86-91) to illustrate this phase of the work and to exemplify the evidence for the brief summary conclusions regarding the meaning of the data in question.

In all cases except Haapiti, the dominating **frenata** class sets the local mode. Sporadic individuals of a weakly represented class may be essentially similar, as in the case of **bisecta** of Vaianai 1907 (table 86) or **cestata** in Maraarii (table 88), or they may be distinctly different, as **strigata** of Vaianai 1907 (table 86), sinistral **zonata** of Uufau 1907 (table 87). In the latter case the small group of rarer individuals is usually compact and seems to form a true genetic family; indirectly, therefore, they give evidence of the hereditary control of their patent distinctions.

A given color class may change its statistical relations with the passage of time, in one and the same locality; the **strigata** of Maraarii 1907 are noticeably larger than **frenata** of the same year, while in the 1923 series this relation is reversed (table 88).

In different subdivisions of one valley, as well as in contiguous valleys, two color classes may exhibit diverse relations; the color classes **atra** and **frenata** of Maraarii (table 88), Faataofe (table 89) and Roroie (table 90) well illustrate this point.

The independence of the dextral and sinistral components of a single association is shown by the different statistical relations of the color classes of the two form-groups. Illustrative figures are given for Uufau (table 87) and Morioahu (table 91).

In brief, the genetic factors which are responsible for the distinctive color patterns are inherited without correlation with the factors for spirality or with the factors for absolute stature and proportions. There is no evidence that they are affected by external circumstances.

PARTULA SUTURALIS STRIGOSA Pfeiffer—STRUCTURAL CHARACTERS

In marked contrast with *vexillum*, the variety *strigosa* occupies a compact sector in the southeastern part of Moorea, with very clearly defined limits (plate 14). The earlier accounts by Garrett and others make more of its distinctions in color than they do of the structural aspects. The most noteworthy among the latter are the smaller size and smaller tooth. The variety is well illustrated by the shells of figures 21 to 31, plate 21, and figures 1 to 28, plate 22.

The members of this variety are always dextral so far as my experience goes. The collections comprise 6661 individuals of all ages—adult, adolescent and embryonic.

Taking the colonies in geographical order (table 92), that of the small interpolated area of Paia is interesting because its members are not very different structurally from the *vexillum* association of Atimaha. They are clearly *strigosa*, as the qualities of color show.

The Maatea series of 1907 and 1924 differ in the width and in the proportions of the whole shell. Other characters are essentially the same.

Haumi Valley is specifically mentioned by Garrett, and hence its inhabitants have the same primary interest as the *vexillum* of Vaianai. Apparently the structural characters fluctuate with the passage of time, for changes from 1907 to 1919 and from 1919 to 1924 are indicated by the figures. As in the case of the Maatea series, the members of the collections of later years are smaller in actual stature, although the proportionate measures are much the same throughout.

In Hotutea and Atiraa, the same diminution in stature has taken place as in the more southern valleys. The proportionate measures have not altered in the same ways in these two localities. Beyond Atiraa, we come to the Vaiare region where *vexillum* again occurs. The dimensional contrasts are even greater at this contact than at the south, where Paia and Atimaha adjoin.

By way of summary, the principal points established by the statistical data are two. The variety is relatively uniform even as compared with a series of *vexillum* colonies occupying an equivalent area. The second is the reduction of the shells in length in the interval from 1907 to 1924.

When the figures relating to the parietal tooth are reviewed (table 93), the structure in question proves to be relatively weak, especially as compared with the *vexillum* of the areas with which Garrett was familiar. In this we find the justification for the statement of that author regarding the points of difference between the two primary varieties. In point of fact, however, many of the *vexillum* colonies of the inner circle between Tefeo and Paparoa, which Garrett did not find, exhibit an even lower development of the parietal tooth.

PARTULA SUTURALIS STRIGOSA Pfeiffer—COLOR CHARACTERS

The second primary division of *P. suturalis*, namely *strigosa*, is clearly distinguished by certain features of collective coloration, as it is in structural characters. Several of the color types are common to both varieties, it is true, but when *strigosa* is taken as a whole its distinct individuality is apparent.

Recalling the fundamental points in the literature, Pfeiffer's original specimen was described as whitish with fulvous and rufous streaks; and as no mention is made of revolving bands, this would be assigned to the class **strigata**. Garrett speaks of the presence of all of the color varieties shown by *vexillum* of Vaianai, adding that the uniform dark-colored shells are more frequent in *strigosa;* this last statement can not hold today, for the class **atra** is relatively more abundant in *vexillum* of Maraarii and Roroie than it is in *strigosa*. Conspicuous strigations are especially characteristic, he says further, and their combination with spiral bands gives the shells a tesselated appearance. These features are prominently displayed by the

Haumi colonies of today and by the *strigosa* of other valleys which were not explored by Garrett, so far as the record goes.

The full census of the color classes in my own material is given in table 15, in terms of the absolute and of the relative numbers in each locality. The significance of variations in color composition is to be considered after the several kinds have been duly described.

Without regard to numerical abundance, the first to be noted is called **pallida** (plate 21, figs. 31, 32) in recognition of its very light color; the shell is not decorticated. Garrett states that he found three specimens of this nature in Haumi. In my own collections it appeared only in Haumi, in three examples out of a total adult series of 1979.

The second class is the one to which Pfeiffer's type belonged, namely **strigata** (plate 21, figs. 33–40). Here the shell is devoid of revolving bands and it is more or less conspicuously striped transversely with lighter and darker color. Taken by themselves these shells would seem to form a single group, but the characters of other classes indicate that **strigata** is really made up of two orders, although it is not always possible to assign a given shell to the one or to the other. In one kind, the general corneous-brown color of the shell is crossed by strigations of *deeper* brown (plate 21, figs. 33–35). In the other, the ground-color is deeper brown, verging toward that of **phæa** to be described beyond; this is striated transversely by *lighter* color (plate 21, figs. 36–40), and hence the general dark brown is interrupted as in the color orders of fasciated types distinguished as **alternata**. The class as a whole is well represented throughout the entire territory of *strigosa*.

Shells with two revolving bands form the class **frenata**, as in *vexillum* (plate 21, figs. 41–50), although here they fall into two well-marked orders. When the bands are distinct and continuous throughout they are named **frenata vera** (plate 21, figs. 41–47). The stripes may be of medium tint (plate 21, figs. 41, 42) or deeper in color (plate 21 figs. 43–46), and near one another (plate 21, fig. 41) or wider apart (plate 21, fig. 42); they vary much in their width also. The color order named **frenata alternata** is distinguished from the former by numerous narrow and light-colored transverse interruptions of the bands (plate 21, figs. 48–50); in consequence the characteristic bands of the class are rendered indistinct, and they may be almost evanescent. The peculiar result does not seem to be due to a lack of the factors of the bands themselves but to an entirely independent and superimposed factor for lighter transverse markings.

With the next class, **cingulata** (plate 21, fig. 51; plate 22, figs. 1-10), we encounter a form of coloration which is a peculiar possession of *strigosa*. In some valleys it dominates all others. The diagnostic feature is a single median band of deep color which extends over a ground-tint of varying depth. When the band is full and distinct, the type is called **cingulata vera** (plate 21, fig. 51, plate 22, figs. 1-5). Darker strigations often occur (plate 22, fig. 3), sometimes to an extreme degree (plate 22, fig. 5). An added band nearer the base is very rarely displayed (plate 22, fig. 2). In **cingulata alternata** there are superimposed transverse streaks of lighter hue which interrupt the characteristic band and dilute it as well (plate 22, figs. 6-8).

Two very odd specimens were found in Maatea in 1907 where the **cingulata vera** pattern was combined with what is later distinguished as the **zonata alternata** coloration (plate 22, figs. 9, 10).

While the class **zonata** occurred with some frequency in *vexillum*, it is relatively rare and local in *strigosa*. The broad revolving zone of deep color is sharply contrasted with the narrow girdle of **cingulata**, more clearly in **zonata vera** (plate 22, figs. 11-14) than in **zonata alternata** (plate 22, figs. 15, 16), whose ordinal differences are the same as before.

The **bisecta** type is the antithesis of **cingulata**, and it is essentially like the class of *vexillum* so-named. The colors are full and strong in the order **bisecta vera** (plate 22, figs. 17-21); in **bisecta alternata** (plate 22, figs. 22, 23) the lateral areas of color are greatly affected by the lighter transverse lines. There is still another order within this class which is sufficiently abundant in some valleys to justify its recognition as such; it is called **bisecta lata** because the lateral areas of deeper color are contracted toward their outer boundaries, thus causing the median zone of lighter color to expand (plate 22, figs. 24, 25). A counterpart shell appeared in the *vexillum* colony of Vaiare-Puutu (cf. plate 21, fig. 22).

The last color class comprises dark brown shells that are nearly or quite uniform in their coloration. They correspond with **atra** of *vexillum* but never gain the rich blackish pigmention of **atra**, and few shells approach that extreme; they are named **phæa** (plate 22, figs. 26-28). In some shells there is a suggestion of the **alternata** factorial effect, but it is not here possible to assort the material into two orders any more than it was in the case of **strigata**.

Having enumerated the series of color types, we pass to their features of distribution (table 15). The valleys inhabited by *strigosa* are five in number, in continuous series. Paia is not especially important as it is a small coastward interject which was examined to ascertain whether it was occupied by *strigosa* or *vexillum*, in order to fix the boundary between these two primary varieties; its *suturalis* were unmistakable *strigosa*. The four major valleys were explored during the earlier period of 1907 and also during the later year of field work, 1924. Relatively large numbers of the species were obtained, and the analytical results are perhaps more definite than in the case of *vexillum*.

When the annual series are compared some differences appear, it is true, but on the whole no really drastic alterations in colonial color composition are indicated. The proportionate figures are remarkably consistent.

The peculiar light form **pallida** is a rare occupant of Haumi Valley alone, as it was in Garrett's time. The type is holding its place, but somewhat precariously. Broadly banded shells of the **zonata** type constitute a definite component of the Maatea series, but elsewhere they are absent except in the Haumi series of 1924. Of course it would be difficult to suggest other than congenital factors for the appearance of **pallida** in Haumi and of **zonata** in Maatea; the point does not require argument.

The **cingulata** class is not only an exclusive form of *strigosa* but it is also the dominating one in Haumi, where its preponderance is slight, and in Atiraa, where

it far outnumbers all other classes. In Hotutea the **frenata** class forms the majority. With two or with all three of its color orders represented, **bisecta** is also universal in the four major areas, and in Hotutea its numbers are quite large. Dark shells of the **phæa** class are abundant in Haumi. The **strigata** class, with its bold transverse markings, is a prominent member of the Haumi associations.

TABLE 15—*Partula suturalis strigosa. Census of the color classes and color orders (all dextral)*

Valley	Year	Total	pallida	strigata	frenata		cingulata		zonata		bisecta			phæa
					vera	alternata	vera	alternata	vera	alternata	vera	alternata	lata	
Paia	1919	14	.....	7	.....	.....	2	4	.....	.....	.....	.....	.....	1
Maatea	1907	238	.....	34	27	9	41	53	11	20	5	36	.....	2
Maatea	1924	341	.....	30	66	61	41	65	21	23	10	22	.....	1
Haumi	1907	421	.....	111	33	26	77	127	.....	.....	5	28	.....	14
Haumi	1919	328	1	73	20	15	37	75	.....	.....	28	35	10	34
Haumi	1924	1,230	1	342	113	80	158	334	2	2	30	94	15	58
Hotutea	1907	283	.....	10	157	9	23	7	.....	.....	37	10	21	0
Hotutea	1924	641	.....	27	382	17	38	70	.....	.....	50	29	22	6
Atiraa	1907	126	.....	15	4	0	81	12	.....	.....	.....	1	0	0
Atiraa	1924	211	.....	17	4	11	144	24	.....	.....	2	3	1	2
All	.....	3,833	3	666	806	237	642	771	34	45	167	258	74	130
					1,043		1,413		79		499			
Per cent														
Paia	1919	.....	.....	50.00	.....	.....	14.28	28.57	.....	.....	.....	.....	.....	7.14
Maatea	1907	.....	.....	14.28	11.34	3.78	17.23	22.27	4.62	8.40	2.10	15.13	.....	0.84
Maatea	1924	.....	.....	8.80	19.35	17.89	12.02	19.06	6.16	6.74	2.93	6.45	.....	0.59
Haumi	1907	.....	.....	26.36	7.84	6.17	18.29	30.17	.....	.....	1.19	6.65	.....	3.32
Haumi	1919	.....	0.30	22.25	6.10	4.57	11.28	22.87	.....	.....	8.54	10.67	3.04	10.57
Haumi	1924	.....	0.16	27.80	9.19	6.50	12.84	27.15	0.16	0.16	2.44	7.64	1.22	4 72
Hotutea	1907	.....	.....	3.53	55.58	3.18	8.13	2.47	.....	.....	13.07	3.53	7.42	3.18
Hotutea	1924	.....	.....	4.21	59.59	2.65	5.93	10.92	.....	.....	7.80	4.52	3.43	0.94
Atiraa	1907	.....	.....	11.90	3.17	7.14	64.29	9.52	.....	.....	.....	0.79	1.59	1.59
Atiraa	1924	.....	.....	8.06	1.90	5.21	68.27	11.37	.....	.....	0.95	1.42	1.90	0.95
All	.....	.....	0.078	17.395	21.028	6.183	16.749	20.115	0.871	1.174	4.357	6.731	1.931	3.391
					27.211		36.864		2.045		13.019			

When the **vera** and **alternata** orders are scrutinized with reference to their relative numbers, additional evidence of factorial variation is disclosed. In the **cingulata** of Haumi, the interrupted pattern definitely outnumbers the full coloration, while in Atiraa the latter predominates. In the **frenata** class, **vera** overwhelms **alternata** in Hotutea, but in Atiraa **alternata** is clearly more abundant than **vera**.

In brief, the earlier and the later collections in each valley agree essentially. The proportions of the several color components differ much when separate valleys are contrasted, even when they are immediate neighbors like Hotutea and

Atiraa. Similarly the **vera** and **alternata** orders bear diverse relations to one another within different classes of a single association and within identical classes of different valleys. The environmental circumstances are indubitably similar in the valleys of the compact sector where *strigosa* occurs.

Carrying the study of the color classes to the final stage, their statistical characters come into consideration; and in the case of *strigosa* all of the groups are described in terms of the mean values of their structural characters (table 94). While the voluminous data are well worthy of detailed analysis, only a few of the more obvious points need be noted.

The **pallida** shell of the 1919 Haumi series is larger than its associates, while the two individuals of the 1924 collection are more average. It is to be expected that the descendants of an aberrant type would approximate to the general average when the progenitor is under the necessity of crossing with an individual of a class other than its own.

The **phæa** components of Maatea are collectively short and slender in 1907, long and slender in 1924; thus it appears that some structural change may come about in a group of snails which remain the same in their primary coloration.

When **strigata** is followed from one valley to another, it exhibits very different relations to the average of the whole population. The comparison of the series of 1919 from Haumi with that of Hotutea taken in 1924 brings out this point.

In another connection, the simple statement is made that the **vera** and **alternata** orders of the color classes vary structurally in ways that are analogous to the above. The actual figures have been calculated for several of the associations, but it is not necessary to place them on record.

In summarizing the general results of the analysis of coloration in *strigosa*, the principal point is that this primary variety is characterized by peculiar features which distinguish it from *vexillum* even more sharply than in the case of its varietal structural qualities. The individual associations differ in the proportions of the several color classes and in the relations of the color orders within the classes. Statistical variation among the color classes is independent of coloration in its factorial causation.

EMBRYONIC MATERIAL

By virtue of its wide range and substantial numbers in a large series of localities, *Partula suturalis* provides an abundance of data relating to the embryonic generation. The basic facts of fecundity are first to be discussed, and then the heredity of spirality and of coloration will be taken up.

The combined statistics of productivity (tables 95, 96) are derived from 13,466 recorded adults; 10,359 of these were gravid, or 76.93 per cent. The collections were made during the same season of every year, from June to September, and hence no comparison can be made with the condition of the species during the hotter and wetter months. The colonies vary greatly among themselves and give no evidence of a general breeding season like that which was shown to occur in the species of Guam. In 1907 the *strigosa* series was secured within three days; the percentage of gravid was 52 in Haumi, 68 in Maatea, 71 in Atiraa, and 86 in

Hotutea. Tupuna and Vaiana were explored at about the same time in 1923; the percentage of bearing adults was 75 in the latter and 85 in the former. Many other illustrations might be drawn from the records. Eliminating the very small series like those of Aareo and Paparoa, the lowest reliable figure is 40 per cent (Atiraa, 1924) while the highest is 94 per cent (Mouaputa, 1923).

The egg capsules are heavily charged with calcareous substance, thick and white. Out of 15,891 eggs, only a single one had a clear capsule; hence this condition is rarer in *suturalis* than in any other species which normally possesses the impregnated capsule. The point of interest is that the aberration duplicates the condition which is normal in whole species like *P. gibba* of Guam and *P. hyalina* of Tahiti, and in an entire variety as in the case of *P. tæniata striolata* of Moorea.

The young numbered 13,014 in all. Therefore the total embryonic contents of the gravid adults amount to very nearly 29,000. The general average for gravid individuals is 2.79 items, and 2.15 for the whole series of recorded adults. Considerable variation occurs in both of these relations, quite apart from the percentage of fecund members of the associations. In the Roroie series, the average of the embryonic items was 3.59. In the 1924 series from Atiraa, which showed so low a percentage of producing snails, the average number of embryonic items within such as were fecund was only 1.94. When the geographical summaries are compared, the irregularities become reduced somewhat, but the extreme territory from Aareo to Faatoai and the outlying sector from Vaiare to Maharepa display much lower average figures than the areas of the inner circle within the mountains.

Aberrations in the order of the embryonic contents are relatively few in *suturalis*, only 12 in all coming to light. These are cases where an "egg" lies distally in relation to a "young" snail. Owing to the thickness of the shell it can not be ascertained whether such misplaced "eggs" are really fertile or are merely capsules which have not received zygotes; only the former would be true anachronisms.

Twin embryos within a single capsule were found in a single case; one similar instance was found in *P. mooreana*.

The inheritance of the mode of coil is a subject of fundamental importance. Broadly treated, the associations of *suturalis* fall into three groups: exclusively dextral, exclusively sinistral and mixed. The former include no cases whatsoever where sporadic sinistral young were produced by dextral parents. In the Maraarii colony of 1907, one dextral embryo was found in a reversed parent; this is a true case of mutation, for no dextral adults were found for miles about. In Tupuna and in one of the subsidiary Vairahi collections, sporadic adolescents of direct coil were found among exclusively sinistral adults, but these may have been the unchanged young of very rare dextral snails, which do occur in neighboring localities.

The mixed colonies are the most interesting (table 97); they occur in three widely separated regions where the transition is made from an area of dextral inhabitants to an area of sinistral colonies. The first region extends from Oio to Uufau, the second includes the subordinate sections of Vaiare Valley, while the third comprises Morioahu and Morioahu East definitely, together with several mixed associations in the general Vairahi territory which have small dextral components.

The Oio series of 1919 included eight reversed adults but no embryonic records were obtained from this series; the point has been stressed elsewhere that the later series of 1923 from this valley contained no sinistral component. The Haapiti series of 1907 (table 97) was 92.53 per cent dextral; some adults of each kind bore young of the opposite mode of coil, but the dextral young of reversed parents were not equaled by the sinistral young from dextral parents, with the result that 94.32 per cent of the embryonic generation were dextral. Only a single reversed adolescent was found in the 1923 series from Haapiti.

In Uufau the dextral components are outnumbered by the contrasted kind. The figures for the 1907 and 1923 series (table 1) show clearly that a colonial change had taken place in the interval, despite the fact that parents of each mode of coil produced young of both kinds; but the sinistral products of dextral ancestry were fewer than the dextral offspring borne by reversed adults. In the embryonic generation of 1923 there is a slightly higher proportion of dextrals than in the group of bearing adults; and as the latter comprise a larger relative number of directly coiled individuals than are found in the population at large, there is some indication that the trend from sinistral to dextral is still continuing. These aspects of the Uufau data have been discussed in an earlier connection.

Passing to the Morioahu region of transition, the eastern association seems to be stable. But the material of Morioahu proper shows a remarkable relative increase in the sinistral component. The bearing adults do not differ from the general population in this case. The data for the Vairahi region are fragmentary and not worthy of full record.

Turning to Vaiare, the Faamaariri series include substantial numbers of both kinds. Although there are some discrepancies, on the whole the colonies of this subdivision seem to be relatively stable. The abundant data provided by the mixed colonies here show to what extent snails of one mode of coil produce offspring of the opposite character. The important point must be recorded verbally that *as a rule* all of the young present at one time display the same mode, whether or not this is the same as the parental form. Of course it is only when two or more young are present that this generalization holds. But five discordant cases have been found, all of them in the Faamaariri series. Three were dextral members of the 1919 series, and each of these bore one sinistral embryo and one dextral embryo. Two came to light when the second 1923 series was examined, where the contents were the same as in the foregoing; one of the parents was dextral while the other was sinistral. Similar instances of mixed broods have been duly noted in *P. mirabilis* and *P. mooreana*.

There has been considerable discussion recently of the problems presented by species of snails where both modes of coil occur. The fullest investigations have been made by Boycott and Diver[1] in the case of *Limnæa*, where in general the offspring of one type collectively repeat or depart from the parental form, but where also broods of both kinds are produced by one and the same individual. Sturtevant[2] has made an ingenious theoretical suggestion that maternal inheri-

[1]Boycott and Diver, Proc. Royal Soc., 95 B, 1923.
[2]Sturtevant, Science, vol. LVIII, No. 1501, 1923.

tance under antecedent chromosomal control takes place; if so, then the young produced by the maternal parent should all exhibit the same spirality. Morgan[1] has accepted Sturtevant's theory. Elsewhere[2] I have discussed the subject, presenting the facts in the case of the Faamaariri colonies of *suturalis*, to which the instances found in *P. mirabilis* and *P. mooreana* are added in the present volume, and contending that the suggested explanation does not hold for the positive instances of mixed broods in Partula.

Recently, however, and since the main body of the present volume was written, new light has been thrown upon this whole subject. Boycott, Diver, Garstang and Turner have published[3] a full account of their extensive and brilliant studies on *Limnæa peregra*, continued throughout a period of ten years. The British authors demonstrate the Mendelian inheritance of the direction of coil, but with segregation in the *third* filial generation instead of the *second*; thus their inductive results are in accord with Sturtevant's deduction, and they establish a most interesting case of so-called "maternal inheritance." Before this later report on the British species of Limnæa had appeared, I had procured direct and reversed individuals of a species of Limnæa from the high mountainous region of Kauai, Hawaiian Islands, and had successfully established them in the laboratory at New York. With the collaboration of my colleague, Professor Florence de L. Lowther, experiments have been carried on with sufficient fulness to corroborate the conclusions of the British authors so far as the fundamental procedure is concerned. And yet a few cases have been found, like the exceptions reported by the British authors, where *direct and reversed individuals are produced by a single isolated parent.* Such instances are exactly similar to the rare cases in *Partula* where both kinds of young are borne in the brood pouch of a gravid individual, cited in the present volume. These exceptional cases appear to be outside the scope of the principles established empirically by the British authors and confirmed by our investigations on another species of Limnæa. Whether or not they can be brought into harmony with the standard procedure remains for further research.

The final topic is the inheritance of the distinguishable forms of coloration. The fundamental difficulty here as in other species is that in the vast majority of cases the definitive characters of color develop only after the young are born. The material is not suitable for a detailed analysis from which otherwise it might be ascertained whether the color distinctions are inherited in Mendelian ways.

One general conclusion is justified, namely, that the color classes are not independent and isolated in their mating. In rare instances definite indications of the color pattern are evident in unborn young. It is interesting that precocity of this nature is seemingly a colonial feature, subject to variation, for a larger proportion of distinguishable young appear in the Maraarii associations than in those of Morioahu or Roroie, despite the bold contrasts exhibited by adult classes of the latter regions. Very few young of *P. suturalis strigosa* can be assorted as embryos.

[1]Morgan, Scien. Month., vol. XVIII, No. 3, 1924; Exper. Embryol., 1924.
[2]Crampton, Science, vol. LIX, No. 1538, 1924.
[3]*The inheritance of sinistrality in Limnæa peregra*, Philosophical transactions of the Royal Society of London, Series B, volume 219, 1930.

A few specific instances may be given in support of the conclusion that the color classes interbreed. Among the young of **strigata** in Maraarii, distinct **bisecta** occurred. Two sharply marked **frenata** and one **bisecta** were produced by **atra** adults in the same locality. Two **zonata** embryos appeared among the offspring of **bisecta** parents, and the obverse relations of the color patterns in question makes these instances especially noteworthy. Without doubt, there are no absolute barriers to mutual intercrossing on the part of the several color types.

SUMMARY AND CONCLUSION

With its long standing since 1855 and with its wide representation in the collections of the world, *Partula suturalis* arrays itself with *Partula mooreana* and *Partula tæniata* in a position of marked contrast with all of the other species of Moorea, which have come to light only in the course of the present research. On the whole, its standing has been unchallenged, with the exception of Garrett's insistence for a time that the species was *Partula lineata* Lesson; later Garrett abandoned that view.

The species is represented in the collections of the present investigation to the extent of 14,640 adults, together with partly grown and advanced embryonic individuals which bring the total number to 33,452. This wealth of material is valuable on its own merits because it affords ample intrinsic evidences for the problem of organic differentiation in wild nature, without the human control which guides the course of generations of experimental subjects in the laboratory. The outcome of its analysis is in full accord with the results of laboratory studies in so far as the changes that have been demonstrated are not referable to environmental circumstances.

Garrett gave a circumstantial account of the components of *Partula suturalis* known to him, which account has served as the basis for my own work. The latter comprises earlier studies during 1907 and 1909 as well as later and more detailed researches from 1919 to 1924. By virtue of these circumstances the record of the species is known to some degree for a considerable period of time. The elucidation of the general nature and history of *Partula suturalis* is much facilitated by the conclusions derived from the other species with simpler make-up and less extensive territories. In its turn, *suturalis* displays many relations which are of material value for the task of analyzing the final complex species, *Partula tæniata*.

When the present areal extension of *suturalis* is compared with its distribution as Garrett described it, a noteworthy expansion seems to have come about in recent decades. Garrett's statements are not to be accepted without qualification, it is true, and without doubt *suturalis* existed in regions which he did not explore; but the case does not rest solely on the areal comparison in question. The material itself provides intrinsic evidences that this species has actually extended its sphere from the central part of Moorea on the coastward side so as to occupy almost all of the habitable territory of high barometric level, except that of the Rotui sector.

Two well-distinguished varieties compose the species, namely, *Partula suturalis vexillum* Pease and *Partula suturalis strigosa* Pfeiffer. The latter is still

confined to a compact sector of the outer circle of valleys in the southeastern part of Moorea, where Garrett found it. In sharp contrast, the former has migrated to the extreme northeast and northwest where it exists in an exclusively sinistral form, while in the original area of occupation the variety is now exclusively dextral. Without relying implicitly upon Garrett's statements, my own collections give reasons for the belief that the change from the direct to the reversed mode of coil took place as a concurrent process during the invasion by *vexillum* of the territories remote from its prior headquarters.

The structural characters of the species in its entirety are accurately defined by biometric constants (table 98) which serve also for a precise comparison with other species, described in analogous terms. The dextral and sinistral groups of *vexillum* and the dextral variety *strigosa* are also comprehensively defined, for purposes of comparison. The *vexillum* shells with direct coil are distinctly larger and more slender and the spire is proportionately longer, as compared with the sinistral series. Combining the two groups of *vexillum* shells the contrasts with *strigosa* appear with clearness; the figures of table 98 do not require verbal explanation.

The two varieties are naturally somewhat alike in the kinds of their color components, but in coloration as in structure definite differences are disclosed. *Partula suturalis strigosa* is distinguished by the dominance of the **cingulata** type, with its single median band, while the **frenata** pattern, with its two revolving stripes, is the prevailing type in *vexillum*. The former variety is still further marked by the prevalence in many classes of transverse streaks which interrupt the revolving bands and stripes in the fasciated classes, with a most distinctive result.

The colonies vary from valley to valley in structural respects and in coloration. The precise statistics relating to the former reveal the same kind of variation which is shown by the individual variants within a single colony. In the case of the diversities within one association, the facts are not to be accounted for by invoking differences in outward circumstances; it would be equally unreasonable to refer the colonial variations, or the resolution of the whole species into its two distinct varieties, to environmental factors as such. The same line of thought leads to the conviction that the qualitative features of color and color pattern are likewise congenital in their determination, and that their variations from colony to colony express the diversities of the innate factors which control these features.

Striking departures from the average are exhibited by certain individuals which differ in some structural detail of size or form, or in some peculiarity of coloration. They may be deemed mutations, although it is not always possible to complete the case as it was in some of the instances in *Partula mirabilis*. The appearance of novel forms among others which conform to the colonial standards, sometimes on the same leaf with the latter, supports the view that they are true congenital mutants.

Reviewing the whole species in a general way, it proves to be an ally of *Partula dendroica*, occupying part of the Rotui sector from which *suturalis* is completely absent. A common primordial stock must have ranged more widely over Moorea when the island was higher and more heavily forested. Local differentiation led the

colonies of the Rotui region to vary in the direction of the present species, *dendroica*. The ancestral stock apparently contracted its range so that it remained elsewhere only in the outer circle of valleys, in which it became resolved into the definitive varieties of *vexillum* and *strigosa*. The latter has conservatively remained within the bounds of the area where it assumed its final form, while the former entered upon a period of territorial expansion and morphological change, particularly in the direction of its spirality.

An inspection of the species of Tahiti and Raiatea discovers forms whose general qualities are sufficiently like those of *suturalis* to justify the view that they and *suturalis* have had a common ancestry. In no other way can the likenesses be explained. As the regions where the members of this morphological group exist are separated islands, and as the snails have no active or passive means of transport from one island to another, the conclusion is that the present island areas were formerly connected by actual land; the connections in question have disappeared as a consequence of the subsidence of the whole range to which the islands belong. The alternative theory, that islands like Moorea, Tahiti and Raiatea are emergent products of volcanic activity, may possibly be defended on geological grounds, but it does not provide for the establishment of colonies of *Partula* upon newly arisen islands by introduction from other regions, by acceptable agencies, and it does not account for the striking endemicity of the species of *Partula* in the Society Islands and elsewhere.

CHAPTER XII

PARTULA TÆNIATA Mörch

GENERAL CONSIDERATIONS

The array of Moorean species of *Partula* that begins with the least numerous and most sharply restricted and extends to the more complex reaches its culmination in the assemblage of wide-spread varieties which constitute the one species of *Partula tæniata*. Taken in its entirety, *tæniata* far outnumbers all of the other primary forms of Moorea, and some of its representatives are found in every area of the island which presents suitable ecological conditions for the existence of any *Partula* whatsoever. While the amplitude of its range of variation is not so great as in the case of the dominant species of Tahiti, *P. otaheitana*, yet it presents an interesting parallel to the latter in its ubiquity and in its local diversification within the limits of its variation as a whole.

The original description was published by Mörch in 1850 on the basis of specimens "purchased from a whale fisher," and attributed wrongly to the Fiji Islands. The first name of *Bulimus* (*Partulus*) *tæniatus* was soon altered to the proper form, *Partula tæniata*. With the possible exception of its analogue, *P. otaheitana*, no other species has received more attention from the specialists in the genus, such as Pease and Hartman. But Garrett is the naturalist whose work is by far the most important because he collected much of the material with which Pease and Hartman dealt; on account of his detailed knowledge of the field, the greatest weight must be accorded to his judgment regarding the distribution, characters, locations and relationships of the several components of *tæniata*. Pilsbry has relied in the main upon Garrett's work, checked by a thorough review of the available museum collections. The present account, based upon a long and close acquaintance with abundant material secured personally, largely confirms the views of Garrett and Pilsbry as to matters of relationship and status, while it records additional information and observations which complete the entire scheme of the variation and distribution of *tæniata*.

While my researches have not neglected any other species, *tæniata* has necessarily commanded the most attention. The first studies of 1907 and 1909 were made with due respect to Garrett's written descriptions and illustrative chart. As in the cases of *P. suturalis* and *P. mooreana*, the then condition of the present species seemed to be essentially what Garrett described, although certain colonies were found which did not conform exactly. The comprehensive explorations of later years added a wealth of material which served to give definite conclusions regarding the make-up of the whole species, as well as the limits of distribution of the several primary components. Only here and there was proof obtained that changes had taken place in *relatively* recent times, for on the whole the species has long since differentiated into its fundamental elements that have established themselves in contiguous or overlapping territories, with comparatively little in the way of recent

migration and diversification, such as are indicated in the cases of *P. mooreana*, *P. mirabilis* and *P. aurantia*. The antecedent history of the whole species is another subject, to be deciphered through an analysis of the present conditions of the varieties of *tæniata*, with the aid of the results obtained from the study of other and younger species like *suturalis*, *mooreana* and *mirabilis*.

The material in hand comprises representatives from practically every habitable valley and subsidiary area. The adults number more than 32,000, while the supplementary series of adolescents and embryonic young bring the total to more than 57,000. The abundance of this material confers a great advantage and at the same time imposes certain difficulties. Without it the whole species could not have been resolved into its components with confidence; but it is well-nigh impossible to do justice to these components, partly because the distinctions are sometimes relatively small in degree and require very close analysis and because variations among them result in overlapping and seeming duplication, also calling for detailed record. If this species were treated as fully as *P. suturalis*, its description would equal in bulk the entire volume on the species of Tahiti. The present account must necessarily be general, and it is to be regarded as a preliminary outline of a fuller analysis to be prepared in the future.

The fundamental literature must first be brought into the record, although the detailed references need not be cited as they are given fully in the *Manual of Conchology* and in Garrett's monograph. Mörch's original description as quoted by Pilsbry is as follows:

"Shell rimate, conic, pellucid, transversely irregularly plicate, longitudinally very closely waved-striate, under a lurid cuticle, the last whorl encircled with two distant, white, brown-bordered bands; suture appressed, whorls five, a little convex, the last about as long as the spire, obsoletely angular above and below; fold of the columella compressed, twisted. Peristome white, broadly expanded, reflexed. Length 18, diam. 8, aperture inside 8 x 4½ mm."

The particular example serving for the foregoing displayed a form of coloration which is by no means frequent, as will duly appear. Mörch accredited the species to the Fiji Islands on hearsay, but later wrote to Garrett that it did not belong there, as Garrett himself informed Pease in a letter dated March 15, 1882, cited by Smith.

The work of Pease is next in importance, because he described several of the subordinate types of *tæniata* and also because his material, sent to him by Garrett, has the highest authenticity. Lacking Garrett's knowledge of the field and without very large series of shells, Pease made full species of what are really varieties. The most important of these are *simulans*, *striolata*, *elongata* and *nucleola*; the last is really a manuscript name credited by Garrett to Pease. Hartman's work added little if anything to the understanding of *tæniata* for which, at the outset he employed the general name of *P. spadicea* Reeve, making the correction after 1881. Reeve's *spadicea* is also a primary variety of *tæniata*, in my opinion, and I have used the name accordingly. One other primary component is mentioned by Pilsbry as occurring in the collections he reviewed; I have named this *P. tæniata propinqua*, giving its distinctions together with its areal relations at a later juncture. Hartman

established another species as *P. corneola*; but the shells he had in hand undoubtedly belong to one of the major subdivisions enumerated above.

There are therefore six primary components of *tæniata* of which all except one, the new *propinqua*, have been recorded as full species. Their descriptions are as follows:

"*Partula tæniata simulans* Pease.

"Shell elongately ovate, rather solid and dull, finely striated transversely; whorls 5, convex, sometimes marginated; aperture somewhat oblique, oblong oval; lip flatly rounded, edentate. Color plain reddish brown or yellowish or horn-color.

"Variety: Three interrupted transverse bands.

"Dimensions: Long. 17, diam. 10.

"Observations: The above species is decidedly not *tæniata* Mörch, from the Fiigii's. It is closely allied to *P. elongata* Pse., but it is shorter, thicker, lip more flat and wider, and colors more plain."

"*Partula tæniata striolata* Pease.

"Shell shortly ovate, rather solid, narrowly umbilicate, transversely marked with fine crowded striæ; whorls 4½, plainly convex, generally marginated at the sutures aperture oval, edentate, slightly oblique; columella slightly nodosely callous on upper part. Light horn-color, or chestnut horn-color, or chestnut, obscurely finely striped longitudinally.

"Var.: Very rarely encircled by three interrupted chestnut-brown bands.

"Observations: The above has been referred to *decussatula* Pfr. by Mr. Cuming, which inhabits, as reported, the Solomon Islands, but, as we are inclined to believe, the Samoan. Our species is thicker, rather more stout, whorls are not rounded, and the aperture differs from *decussatula*."

"*Partula tæniata elongata* Pease.

"Shell elongate, slender, turreted, thin, transparent, shining, transversely very finely striated, somewhat roughened longitudinally, narrowly umbilicate; whorls 5½, flatly convex, suture somewhat impressed, very rarely marginated; aperture oblong oval, somewhat oblique, edentate, one-half the length of the shell; lip evenly and somewhat roundly reflected. Horn-color or pale rose, striped longitudinally, or wholly straw-color.

Var.: Encircled by three chestnut bands, more or less interrupted."

The description of *Partula tæniata nucleola* 'Pease' Garrett is from Pilsbry's *Manual*, as follows:

"A small, compact, ovate-conic race. The surface is densely and distinctly striate spirally, but little shining, corneous-whitish, corneous-brown with wide indistinct darker and paler streaks, yellowish-brown or chestnut-brown. The short spire is straightly conic; whorls 4¼, the last full below, rounded or somewhat flattened on the back. The columella bears a small but rather acute tubercle in the middle, at the lower end of the axial expansion. There is no parietal tooth, but sometimes the very slight indication of one may be seen.

"Length 15, diam. 9, aperture 8.4 mm.

"Length 16, diam. 8.2, aperture 8 mm.

"Length 14, diam. 9, aperture 8 mm.

"This form is probably more primitive than the typical *tæniata*. It stands very close to *P. filosa* of Tahiti. The two are apparently of common origin. According to Garrett, *nucleola* intergrades with *tæniata*, yet it appears to be as distinct as *elongata* is. The largest examples measure 18 x 10, aperture 9½ mm. It lives in a small valley about two miles west of Opunohu."

"*Partula tæniata spadicea* Reeve.

"Shell perforate, conic-oblong, thin, very minutely decussate, diaphanous, brown-corneous streaked with paler. Spire long-conic, rather obtuse; suture margined. Whorls 5 to 5½, a little convex, the last equal to the spire or a little shorter. Columella obliquely subplicate above. Aperture slightly oblique, oblong-oval; peristome thin, white, broadly expanded throughout, the right margin spreading. Length 18, diam. 8, aperture with peristome 10 x 6½ mm. Marquesas Islands. (Cuming coll.)."

Partula tæniata propinqua is the primary variety to which Pilsbry refers as "another race, tangent from *nucleola*." . . . "The dark-brown shell is profusely striped on the last 1½ whorls with cream-white. The columellar denticle is small and prominent." This variety agrees in general with *P. tæniata spadicea* from which it seems to be a derivative. A formal description is not required as the distinctive characters are brought out in the subsequent section dealing with *propinqua*.

While the foregoing records may suffice for taxonomic purposes, they require the supplement of Garrett's full account of *tæniata*, of its components as he knew them, and of the distribution of these components. This is as follows:

"The metropolis of this truly protean species is in a very large semicircular valley on the north coast of Moorea, where it occurs in prodigious numbers on the foliage of bushes. In the western part of the same valley, where it exhibits less variation, it gradually intergrades with the form which has been distributed under the name of *nucleola* Pease, which has its headquarters in a small, but isolated, valley about two miles west of Opunohu.

"Pease's *nucleola*, which is quite abundant, is usually smaller, more solid, spire shorter, aperture smaller and more rounded, and the columella is more distorted, than in the typical *tæniata*. But in looking over a large number of specimens we notice some examples which can not be separated from some of the smaller forms of the latter species.

"On the southwest part of the island we find *tæniata* tolerably abundant in three valleys, and, like the shells in the western part of Opunohu, it is subject to much less variation than obtains in the eastern part of the same valley. The shells from the southwest coast were described by Pease under the name of *P. simulans*.

"In the third, or more eastern valley, where they come in contact with *P. elongata* and *lineata*, hybrids between the former and *tæniata* are so numerous that any one collecting in that valley only would, without hesitation, pronounce them one and the same species.

"From this point on for several miles, the valleys are inhabited by *lineata*, *Mooreana*, *elongata*, and *lineata* var. *strigosa*, only. But after passing Oahumi, the home of the latter variety, we again find *tæniata*, but nearly as variable as the eastern Opunohu shells, and mixed with the form known as *striolata* Pse., with which it intergrades. Here I found several unmistakable hybrids between *strigosa* and *tæniata*. All the valleys between this latter location and the one nearest to Opunohu are inhabited by the typical form *striolata*, which scarcely differs from *nucleola*, except in being smoother and more variegated with stripes. In a large valley adjacent to Opunohu, we find these shells by thousands; they differ in being beautifully striped like *strigosa*. Here, again, it insensibly graduates into the typical *tæniata*. Whether the inosculation takes place through hybrids or not is a difficult question to decide. In looking over a large collection from the eastern part of Opunohu, I find some of the small forms are not dissimilar to the typical *striolata*, which has suggested the propriety of following Dr. Hartman in consolidating the three forms.

"The typical *tæniata* varies from abbreviate-ovate to elongate-ovate, more or less solid, scarcely shining, smooth or wrinkled with incremental striæ, and the spiral incised lines are very fine, and crowded on all the whorls. The spire is more or less produced half the length of the shell, sometimes shorter or a trifle longer. Whorls moderately convex,

the last one convex or convexly rounded, frequently compressed in the back and right side, which gives it a faint biangular appearance. The peristome is more or less expanded, sometimes considerably so, moderately thick, slanting and labiated within. Columellar lip more or less tortuous, abruptly receding above, which gives it a nodulous appearance. About one in a hundred exhibits the parietal tooth. The following measurements will illustrate the variability in shape:

"Length 17, diam. 9, aperture (including lip) 9 1/3 mill.

"Length 17, diam. 8, aperture (including lip) 8 mill.

"Length 13, diam. 7, aperture (including lip) 8 mill.

"The color is also variable: white, straw-yellow, lemon-yellow, light orange, corneous, fulvous, various shades of brown, sometimes with darker strigations, and frequently spirally banded. The most common style of fasciation consists of from one to four narrow, more or less broke, fulvous or fulvous-brown bands on the body-whorl. Fulvous-brown examples, with two or three pale bands, are not so common. The last appears to be Mörch's type, which he incorrectly assigns to the Viti Islands.

"Pease's *striolata* and *nucleola* exhibit the same coloration as the typical *tæniata*, but are sometimes of a deeper brown, and the former is more conspicuously strigated.

"Dr. Hartman, on the authority of Pfeiffer, quotes *P. peraffinis* Pse. which he adds to the synonymy of *tæniata*. I do not know any such species, and can not find any reference to it in Pfeiffer's monographs. He also regards Reeve's *spadicea* as identical with *tæniata*. Both Reeve and Pfeiffer quote the Marquesas Islands as the habitat of that species, but Pease and Dr. Cox mention having received it from the Solomon Islands. Judging from the description and figure of *spadicea*, I am inclined to consider it distinct and an inhabitant of the latter group of islands."

Garrett firmly held the opinion that *elongata* was a full species and not a variety of *tæniata*, but Pilsbry has come to the opposite conclusion. My own view coincides with that of Pilsbry. I am convinced that Garrett's studies were not as comprehensive as those of the present research, and I believe that the facts unknown to him justify the subordination of *elongata*. Garrett's monograph includes the following discussion of this form:

"The headquarters of this arboreal species is in Vaianai Valley on the southeast coast of Moorea, where it is abundant, associated with *P. lineata* and *P. Mooreana*. It occurs, also, but in less numbers, in a valley to the westward, where it is found in company with *lineata* and *tæniata*. The same valley, which is about two miles from Vaianai, is the limit of the range of the latter species on that part of the island, and hybrids between it and *elongata* are rather common, the same as between *Garrettii* and *Thalia* at Raiatea. To the eastward of Vaianai it ranges through the small valleys for a distance of several miles, as far as Oahumi, the specific center of *strigosa*.

"I can not agree with Dr. Hartman in uniting this species with *tæniata*. It is only through hybrids between the two species that the inosculation takes place. Examples taken in any of the valleys *not* inhabited by *tæniata* prove at once its distinction.

"The type is elongated, thin, translucent, corneous, straw-yellow or pale fulvous, frequently with narrow longitudinal darker stripes, and the rather ample aperture is edentated. The outer lip is thin, simple, moderately expanded. The columella is flat, not nodulous or gibbous. Examples with two to four narrow, light chestnut-brown, more or less broken, revolving bands are not infrequent. They vary in the length of the spire as the following measurements will show:

"Length 17, diam. 7 1/2 mill.

"Length 15, diam. 8 mill."

There are thus six sections or primary varieties of *tæniata* to be considered. Each is in a sense an equivalent of single independent species like *P. aurantia* or *P. mooreana*. Each presents its distinctive qualities, it occupies an area which as a rule is not shared with another variety of the same species, and each has its own history of organic differentiation to be worked out.

Considering these varieties on their general structural merits, they exhibit various degrees of affinity. The variety *elongata* stands by itself, with its slender form, protracted spire, thin texture and attenuated lip. Another relatively independent form is *simulans*, which is more compact and broader, with thicker shell and with a fuller development of the lip; this variety is unquestionably older than *elongata*. The other four varieties form a complex which as a morphological whole is the equivalent of each of the foregoing. The shell is still more compact and solid, the lip is more heavily incrassated, and the columellar margin of the aperture is distinctly nodulated or notched. Apparently this complex represents a still older type of *tæniata* which flourished before the characters of *simulans* were developed in

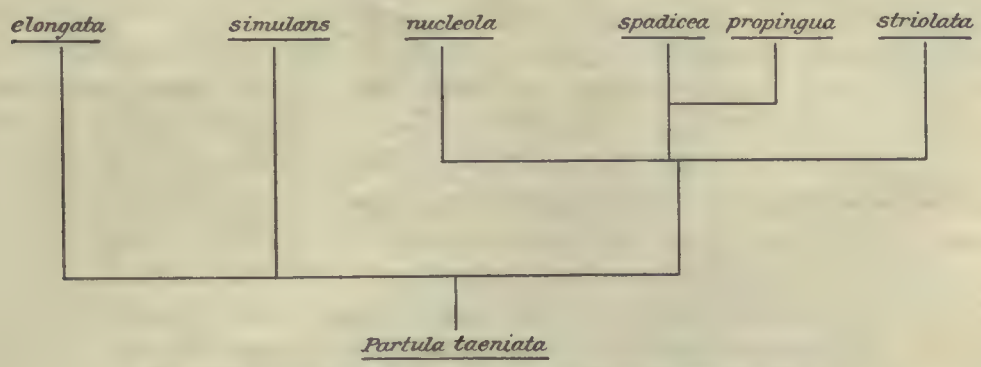


FIG. 6—Interrelationships of the primary varieties of *Partula tæniata*.

a section of the whole population. The old stock of the present complex has differentiated into three subordinate sections, *nucleola*, *spadicea* and *striolata*, each of which occupies its own well-isolated territory; the fourth component, *propinqua*, is an outgrowth from *spadicea* ancestry and apparently it is the youngest of the whole array to gain its distinctions. The interrelationships in question are indicated in diagrammatic form in text-figure 6, which is based on the morphological data without reference to the geographical considerations to be discussed in a subsequent section.

One general topic remains to be discussed before we pass to more special considerations. All of the original descriptions state that the shells of *tæniata* are dextral without exception, and all of the known examples in the collections of various institutions of the world are right handed. In the course of my own studies four sinistral mutants have been discovered among 57,172 individuals of all ages. Two of these reversed snails came to light in the small valley of Taapurau, in 1923 and 1924, respectively; they belong to the variety *simulans*. A single sinistral example of the variety *elongata* was found in Oio Valley in 1919. The fourth specimen was

discovered in 1923 in the southern division of Vaihiaiia Valley, located in the Rotui sector; it is a *spadicea*.

Clearly the Taapurau, Oio and Vaihiaiia specimens are utterly independent in their origins. There is no question of a sinistral stock, with sparse representatives, existing as an independent associate of the prevalent dextral kinds. It is equally evident that the production of reversed mutations is excessively rare in *tæniata*, when only four out of more than fifty-thousand specimens of the species are sinistral. The chances of their discovery would have been very small if comprehensive and abundant collections had not been secured.

But the noteworthy point is that left-handed mutants actually do arise in *P. tæniata*, as they do locally in the dextral species *P. aurantia* and *P. mirabilis*, and as dextral mutants occur sporadically in some of the colonies of the reversed *P. mooreana*.

AREAL RELATIONS

Wherever ecological conditions make it possible for *Partula* to live, representatives of *P. tæniata* are found. The open areas of the coastal plains, certain dry sectors at the extreme northwest and northeast, and the dry ridges between forested valleys are the only places where they are lacking. No limits have been found to their vertical extension where thick vegetation occurs in the upper valleys and on the mountain faces. Whereas all other species require the greater degrees of moisture which obtain at the higher altitudes, this species tolerates much dryer conditions toward the coast, provided that the vegetation consists of shrubs and is fairly thick. At Aareo the animals were found at the very edge of the strand itself, as in the case of *P. gibba* in Guam and Saipan.

The several primary varieties into which *tæniata* has become differentiated occupy their own several territories, making the whole areal scheme of the species most interesting and significant. While there is very little overlapping, there are a few instances where two varieties occur in the same valley, just as two independent species like *P. suturalis* and *P. mooreana* exist in the same locality. When, now, the distribution of the several primary varieties is analyzed, something is revealed of the antecedent history by which the present condition of the species as a whole has come about.

The areas inhabited by the six sections are shown in plate 15. *Partula tæniata elongata* extends continuously through a considerable segment of the outer southwest valleys from Haapiti on the west to Haumi (not Oahumi, as Garrett spelled it) on the east. Uufau Valley, just west of Haapiti, bears *simulans* which inclines somewhat in its collective measurements to the *elongata* type; this may be due to some slight admixture from Haapiti or it may be merely the manifestation of an intrinsic condition of the Uufau *simulans*. Garrett's chart and description locate *elongata* in the same territory; the author speaks of an association of *elongata* and *tæniata*, presumably *simulans*, in a valley two miles to the northwest of Vaianai, which is undoubtedly Uufau, and he notes the occurrence of what he calls hybrids between the two kinds. My present opinion is that the Uufau colony is really *simulans*, some of whose components vary in the direction of *elongata*.

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Paritula taeniata. Present distribution of the primary varieties.

The chart shows that the central circle of valleys is also occupied by *elongata* without any associates of other varietal types, from Maramu Valley to Mouaputa Valley inclusive. Garrett omits all mention of *elongata* in his description of the inhabitants of the inner basin, and he positively indicates *simulans* as existing here. It is possible that *simulans* did occupy this area in Garrett's time and that it has been displaced by a migratory flood of *elongata* from the outer region by way of the Vaianai-Maramu pass between Mount Tamarutofa and Mount Mouaroa. As the earlier chapters have shown, recent migrations of *P. mooreana* and *P. mirabilis* have actually taken place across this pass, although in opposite directions. But *simulans* is so completely absent from the inner area in question that, in my opinion, Garrett did not really explore all of the valleys and merely assumed that the *tæniata* were like those he found in the western part of the wide Opunohu basin. His failure to discover *P. mirabilis* in this territory is a corroborative point in this connection. Without question *elongata* has come to occupy the central valleys from Maramu to Mouaputa during relatively recent times, but it must have been solidly established before Garrett's day, judging from the present situation. Finally there are small colonies of *elongata* in the Rotui sector. The 1909 and 1919 collections from Matapoopoo contain this variety, but the extreme western section of Matapoopoo, explored in 1923, was devoid of it. None were taken in Tepatu in 1919 but a very few were found in that area in 1923. These facts indicate a very recent incursion of *elongata* into the Rotui sector from across the lowlands of central Opunohu and western Paopao.

The variety *simulans* presents a most interesting condition. As Garrett noted correctly it exists in the outer westward circle from Uufau to Pafatu Valleys, as far as any *Partula* occur at all in this direction. It also occupies the inner circle of valleys from Tiaorooro and Faataofe Valleys to Vairahi, on both sides of the lowlands. Again as Garrett described it for his time, *simulans* is present in the outer eastern valleys of Hotutea and Atiraa. In addition, today it exists in the *inner* area of Paparoa Valley, and sparse representatives are also found in the middle or Vaipohe division of Vaiare Valley—the latter being undoubted migrants from Paparoa. Garrett located *striolata* in the whole of the northeast region including Paparoa, and in the eastern half of the Rotui sector as well. But he speaks of the abundant shells in "a large valley adjacent to Opunohu" where they graduate into the typical *tæniata*. I believe he referred to what are actual *simulans* as found in Paparoa.

When we find *simulans* as one and the same variety in the contiguous outer and inner areas of the west separated by intervening *elongata* from true *simulans* in the eastern areas, it is clear that the first variety must have extended continuously across the whole of Opunohu and Paopao at some earlier time. Apparently the eastern and western series of *simulans* have become separated as a consequence of the origin of *elongata* in some central locality and the subsequent expansion of the latter from this place of origin outwards. While they have long been isolated, yet the two sections of *simulans* are still sufficiently alike to be referred to the same primary variety.

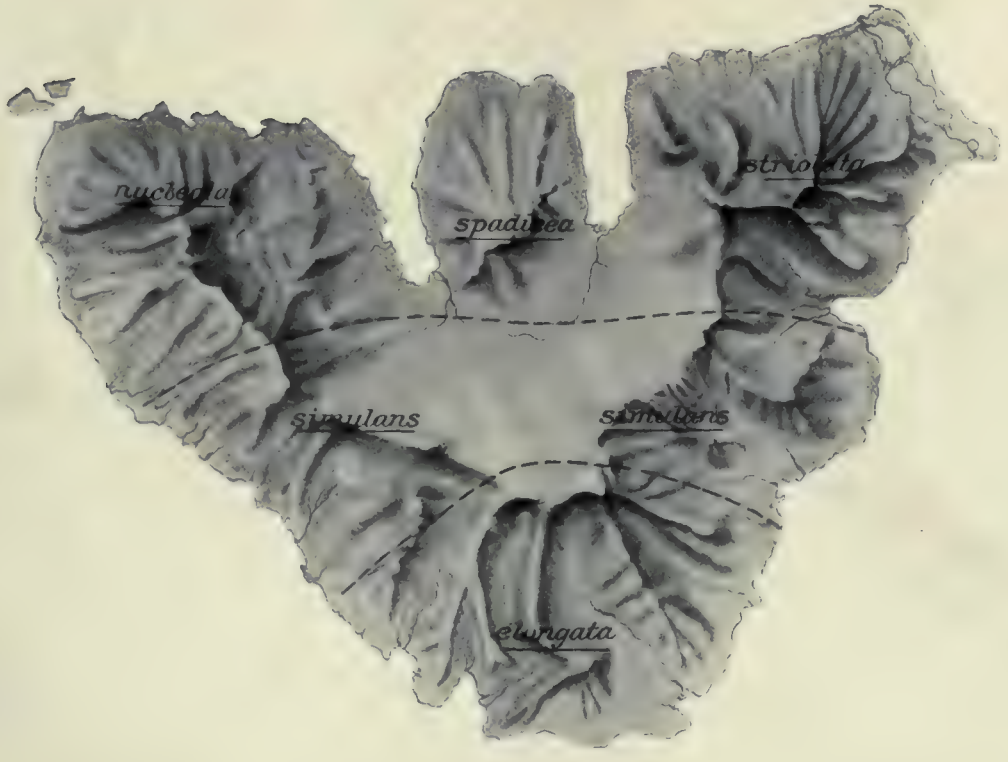
The remaining varieties are morphologically as similar as are the three geographic sections of *simulans* and the three series of *elongata*. Yet they are definitely and widely separated. The variety *striolata* begins in Vaiare and extends throughout the northeastern part of Moorea around to Paraoro on the Paopao Bay side. The variety *nucleola* is confined to the Aareo, Urufara and Faatoai areas in the extreme northwest. The third form, *spadicea*, and its later offshoot, *propinqua*, occupy the Rotui sector. The former holds exclusively all of the valleys of the eastern and northern sides and the outer valleys of the western part, while *propinqua* begins with Tepatu and extends through Matapoopoo and Vaihiaiia. Lately a small group of true *spadicea* has entered Vaihiaiia.

The geographic relations of the three main varieties—*striolata*, *nucleola* and *spadicea*—are somewhat similar to those of the eastern and western sections of *simulans*. The extreme northeast, the northwest and Rotui regions are sharply separated by ecological barriers, and migration from one to another is manifestly impossible. Their varieties are almost as much alike as are the components of *simulans*, and a common ancestry is unquestioned. At some time before *simulans* had come into being there must have been a wide-spread and undiversified stock existing in nearly all of Moorea; this we may designate *primordia*. In different parts of the island, minor diversifications came about, and in the extreme northern sections of the trident island the original stock changed into *pro-striolata*, *pro-nucleola* and *pro-spadicea*; in the southern region, *simulans* gained its distinctive qualities (plate 16A), preempting the territory where *primordia* formerly held sway. In the same manner and at a later time, *elongata* arose, pressing outward to displace *simulans*, as that variety had previously dislodged the antecedents of *nucleola*, *spadicea* and *striolata* (plate 16B). Very little additional change would be necessary to bring about the present situation as depicted in plate 15.

Thus the original condition of *tæniata* was that which is best preserved in the group of *nucleola*, *striolata*, *spadicea* and *propinqua*, while *simulans* presents a later condition, and *elongata* has been the latest to arise. Accepting this conclusion, the problem of extrinsic relations comes up. When the species of other islands are reviewed, that which resembles the postulated *primordia* organization most closely is *P. filosa* of Tahiti. Pilsbry has already recognized the likenesses in question. If the morphological agreements mean a community of origin of *filosa* and of the original stock of *tæniata*, then additional evidence is given that a prior land mass extended between the now-separated islands of Moorea and Tahiti. The leeward island of Raiatea is inhabited by still other forms which approach the so-called *primordia* of the past and *P. filosa* of today; these will be discussed in a subsequent volume.

The general census of the primary varieties is given in table 16. This one species outnumbers all other forms of Moorea and also all of the material that served for the description of the species of Tahiti. In a general way, the actual number of a given variety is correlated with the size of its area of habitation; thus *simulans* has the greatest number, while *propinqua* is least abundant in the whole collection. No obvious differences exist in the real prevalence of this species,

A



B

Earlier (A) and later (B) stages leading to the present distribution of the primary varieties of *Partula tæniata*.

making due allowance for the dryer and therefore more unfavorable localities where inevitably fewer snails would be taken in a given period of collection.

While the adult individuals are the most important, the partly grown or adolescent snails have proved very useful in many cases; at times a particular mode of coloration would be unrepresented in the adult population but it appeared in the array of immature individuals. The rich series of embryonic young is exceedingly valuable, especially for an interpretation of inheritance of characters of coloration.

TABLE 16—*Partula tæniata. General census*

Variety	Series	Region	Adults	Adolescents	Young	Total
elongata	outer	Haapiti to Haumi	D 2,318 S 1	245	1,322	3,886
	inner	Maramu to Mouaputa	3,594	435	3,456	7,465
	Rotui sector	Matapoopoo, Tepatu	251	63	207	521
	All		6,164	743	4,985	11,892
simulans	west outer	Pafatu to Uufau	D 3,382 S 2	261	1,940	5,585
	west central	Tiaorooro to Vaiana	3,346	255	3,025	6,626
	east outer	Hotutea to Vaipua	1,042	112	526	1,680
	east northern	Paraoro, Vaiare	1,645	139	1,624	3,408
	All		9,417	767	7,115	17,299
striolata	All	Vaiare to Paraoro	6,584	169	4,509	11,262
nucleola	All	Aareo to Faatoai	6,778	420	3,673	10,871
spadicea	All	Rotui sector	D 3,115 S 1	269	1,839	5,224
propinqua	All	Tepatu-Vaihiaiia	381	32	211	624
Whole species			32,440	2,400	22,332	57,172

PARTULA TÆNIATA ELONGATA Pease—STRUCTURAL CHARACTERS

The primary varieties of *tæniata* have been duly distinguished and their mutual relationships have been discussed in a comprehensive way; they are now to be taken up for detailed analysis and description. Reasons have been given for the conclusion that these primary varieties are of different evolutionary ages, although they are all descended from a single ancient stock. The youngest variety, *elongata*, is to be taken up first, mainly because the essential geographical facts are somewhat simpler than in the other cases, even though the whole array of varieties is thus treated in the reverse of the evolutionary order of their establishment.

As shown in the previous section, the whole area occupied by *elongata* (plate 15) comprises (1) an outer series of consecutive valleys from Haapiti on the west to Haumi at the east, (2) an inner series of equally consecutive valleys from Maramu to Mouaputa, and (3) two small localities in the southern part of the Rotui sector. The conclusion was reached that the first of these was the most original in the sense that *elongata* gained its distinctive qualities somewhere in the outer circle, that the inner series of valleys has been populated by migration over the low pass between Vaianai and Maramu, and that the Rotui colonies have been very recently estab-

lished by migrants from the Irua portion of the inner region. The three geographical divisions specified are to be kept clearly in mind in the course of the following detailed account of *elongata*, as well as the fact that the colonies of the outer region now exist where *elongata* apparently first gained its varietal distinctions.

The dextral mode of coil is displayed by all shells except only a single reversed specimen taken in 1919 in Oio Valley (plate 22, fig. 62). This is certainly a *tæniata elongata* and not a member of another species even though it is much larger than the general run of its associates (table 99); its contrasts with the reversed *P. mooreana* are clear. No other reversed shell of *elongata* came to light in my own collections, amounting to 11,892 of all ages; and no similar specimen is known in the numerous collections of the world or in the literature.

The ideal shell of this variety is slender and thin, with acute spire and flatly convex whorls; its aperture is narrow, the lip is markedly tenuous and entirely devoid of the nodule on the columellar margin which is so distinctive of other varieties. A parietal tooth is almost completely lacking. The selected representatives shown in plate 22, figures 29 to 62, are alike at least in all of these respects, however much they differ in details of form and in the qualities of coloration. It would be necessary to multiply the illustrations many times, however, to give an adequate representation of the multifarious variations of the adult shells of *elongata*. All that was said on this point in the description of *P. suturalis* applies with greater force to *tæniata*.

Variation in size is quite wide. The shortest shell (12.65 mm.) as well as the longest specimen (plate 22, fig. 34) came from Oio Valley, located in the outer series of localities in which *elongata* seemingly acquired its varietal peculiarities; the extreme specimens do not come to light in later-won regions but in the original area. It is not logical to refer the production of such aberrant individuals to environmental causation. Variations in the proportions of the whole shell and in the size and shape of the aperture are also notably wide, as a survey of the illustrations will discover.

Passing to the biometric characters, the statistics (table 99) show that the series of outer colonies taken collectively, when compared with those of the inner array, are somewhat shorter and broader both in absolute and relative respects, and that their apertures are slightly shorter and narrower, while finally their apertures are slightly shorter in relation to the long axis of the whole shell. As compared with the inner associations, the few colonies of the Rotui sector comprise shorter and broader shells, with shorter and broader apertures, and with proportionately shorter apertures as well. It would seem that the emigrants from the Irua-Mouaputa territory which have invaded Matapoopoo and Tepatu must have been somewhat smaller members of their parent associations; there is nothing discoverable in the ecological conditions of the Rotui sector which could be held accountable for the differences in question. Associated species show no similar reductions.

When the descriptive figures for the several colonies are considered in detail, certain interesting facts come to light. The 1923 series from Haapiti comprises larger shells than those of the 1907 collection. This may mean that the smaller series of the earlier year was taken from a restricted portion of the valley near the coast, while the collection of the later year was more fully representative of the

whole region, and that the quantitative characters actually differ in the various parts of a single valley. On the other hand, the differences in question may indicate real organic changes with the passage of time. The Oio series came from the same area, and they also display a diminution in size for the four-year period from 1919 to 1923. Proceeding farther to the east, a drop is indicated in Atimaha from 1919 to 1923, a possible increase in Maatea from 1907 to 1924, a similar increase in Haumi from 1907 to 1919 with a subsequent drop to 1924. As the ecological circumstances are as constant and uniform as possible, the conclusion is that the structural characters of a given colony may or may not fluctuate somewhat with the passage of time, as their genetic factors may happen to combine and operate.

In the array of inner localities (table 100) the annual comparisons reveal a reduction in size in Maramu, Irua and Poua, but an increase in Mouaputa. The colonies of the Rotui sector (table 101) do not provide pertinent facts for this problem.

The parietal tooth is present only in very rare instances, and the tabulated record may be dispensed with. In the outer range only one shell, taken in Oio in 1923, shows even a faint trace of this feature. Five specimens from Irua, two from Ririofau, and one from Paia exhibit similar traces. It is perhaps significant that 8 out of 111 *elongata* shells from Matapoopoo, secured in 1909, possess small indications of a tooth, for this suggests that this migrant colony in the Rotui sector came from the Irua area.

PARTULA TÆNIATA ELONGATA Pease—COLOR CHARACTERS

Although the qualities of coloration were passed over throughout the foregoing discussion of structural characters, they possess an equivalent value for the problems of variation and distribution. On the whole they are quite independent of morphological qualities in their variation, both individual and colonial. It is significant that the results of their study are in complete accord, in principle, with the conclusions based on structural features alone.

The shells of the several colonies of *elongata* fall readily into two main divisions of unbanded (plate 22, figs. 29-46, 62) and banded types (plate 22, figs. 47-61). The members of the second division also resolve themselves into clearly distinguished color classes, to be enumerated below. The "plain" shells are more difficult to deal with because their tints range from light to dark in such a way that the particular points where divisions of the series are to be made must be somewhat arbitrary. Throughout the years required for the study of this one species, every effort has been made to carry over the same scale of classification from one valley and region to another. While the personal coefficient has been the same, yet no claim is made that the class discriminations have been entirely without error; the figures of the census table (table 17) are to be taken as the best approximations for the time, so far as the unbanded classes are concerned.

The class named **pallida** comprises white or very faintly tinged shells; the apex is devoid of coloring (plate 22, figs. 29, 30) or it displays a faint yellowish or yellowish-red tint (plate 22, figs. 31-33). In some colonies only the first order is present, while both occur in other associations.

TABLE 17—*Partula taeniata elongata. Census of the color classes*

Series	Year	Total	Number								Per cent							
			pallida	fusca	fulva	phæa-purpurea	frenata	zonata	lyra	bisecta	pallida	fusca	fulva	phæa-purpurea	frenata	zonata	lyra	bisecta
Outer series:																		
Haapiti	1907	29	6	14	6	..	3	...	..	..	20.69	48.27	20.69	.....	10.34	.....	.....	.....
Haapiti	1923	161	42	67	40	..	12	...	..	..	26.09	41.61	24.84	.....	7.45	.....	.....	.....
Oio	1919	542	120	204	D 132 S 1	..	52	32	..	..	22.14	37.64	24.72	.....	9.59	5.90	.....	.....
Oio	1923	58	15	22	11	..	8	2	..	..	25.86	37.94	18.96	.....	13.79	3.45	.....	.....
Vaianai	1907	107	55	25	17	..	10	...	..	..	51.40	23.36	15.89	.....	9.34	.....	.....	.....
Vaianai	1919	346	139	99	79	..	26	3	..	..	40.17	28.61	22.83	.....	7.51	0.87	.....	.....
Vaianai	1923	67	36	18	10	..	3	...	..	..	53.73	26.86	14.93	.....	4.48	.....	.....	.....
Paahonu	1919	57	27	8	11	..	4	7	..	..	47.37	14.03	19.30	.....	7.02	12.28	.....	.....
Atimaha	1907	8	1	.....	2	..	3	2	..	..	12.50	.....	25.00	.....	37.50	25.00	.....	.....
Atimaha	1919	449	207	140	66	..	33	3	..	..	46.10	31.18	41.70	.....	7.35	0.67	.....	.....
Atimaha	1923	166	78	53	27	..	7	1	..	..	46.99	31.93	16.26	.....	4.22	0.60	.....	.....
Paia	1919	1	1	.....	.....	..	...	...	..	..	100	.....	.....	.....	.....	.....	.....	.....
Maatea	1907	17	4	8	2	..	3	...	..	..	23.53	47.06	11.76	.....	17.65	.....	.....	.....
Maatea	1924	98	25	55	12	..	6	...	..	..	25.54	56.13	12.24	.....	6.12	.....	.....	.....
Haumi	1907	7	.....	5	1	..	1	...	..	..	.....	71.43	14.28	.....	14.28	.....	.....	.....
Haumi	1919	87	38	38	.....	..	8	3	..	..	43.68	43.68	.....	.....	9.19	3.45	.....	.....
Haumi	1924	119	31	67	20	..	1	...	..	..	26.05	56.30	16.81	.....	0.84	.....	.....	.....
Summary	.....	2,319	825	823	438	..	180	53	..	..	35.575	35.489	18.887	.....	7.762	2.285	.....	.....
Inner series:																		
Maramu	1909	49	6	28	5	..	3	7	..	..	12.24	57.14	10.20	.....	6.12	14.28	.....	.....
Maramu	1919	126	72	25	9	..	14	6	..	..	57.14	19.84	7.14	.....	11.11	4.76	.....	.....
Maramu	1923	42	24	13	1	..	4	...	..	..	57.14	30.95	2.38	.....	9.52	.....	.....	.....
Maramu	1924	323	141	131	27	..	22	2	..	..	43.65	40.56	8.36	.....	6.81	0.62	.....	.....
Tefeo	1923	153	76	.....	31	..	24	22	..	..	49.67	.....	20.26	.....	15.68	14.38	.....	.....
Tefeo east	1923	233	126	12	51	7	15	22	..	..	54.07	5.15	21.89	3.00	6.44	9.44	.....	.....
Fareaito	1923	628	300	35	57	..	45	190	..	1	47.77	5.57	9.08	.....	7.16	30.25	.....	0.16
Fareaito	1924	598	332	35	23	3	60	145	..	..	55.52	5.85	3.85	0.50	10.03	24.25	.....	.....
Irua	1907	90	18	25	18	..	9	20	..	..	20.00	27.78	20.00	.....	10.00	22.22	.....	.....
Irua A	1919	35	20	8	1	..	1	5	..	..	57.14	22.86	2.86	.....	2.86	14.28	.....	.....
Irua B	1919	196	101	35	20	..	10	30	..	..	51.53	17.86	10.20	.....	5.10	15.30	.....	.....
Irua	1923	171	122	21	.....	..	14	14	..	..	71.34	12.28	.....	.....	8.19	8.19	.....	.....
Ririofau	1924	299	34	28	85	..	15	137	..	..	11.37	9.36	28.43	.....	5.02	45.82	.....	.....
Poua	1919	23	11	8	1	..	...	3	..	..	47.82	34.79	4.35	.....	.....	13.04	.....	.....
Poua	1923	51	23	22	1	..	1	4	..	..	45.10	43.18	1.96	.....	1.96	7.84	.....	.....
Mouaputa A	1919	139	52	29	41	..	15	2	..	..	37.41	20.86	29.49	.....	10.79	1.44	.....	.....
Mouaputa B	1919	356	133	52	107	..	47	8	9	..	37.36	14.60	30.05	.....	13.20	2.25	2.53	.....
Mouaputa	1923	82	27	17	17	..	19	2	..	..	32.93	20.73	20.73	.....	23.17	2.44	.....	.....
Summary	.....	3,594	1,618	524	495	10	318	619	9	1	45.019	14.580	13.773	0.278	8.848	17.223	0.250	0.028
Rotui sector:																		
Matapoopoo	1909	119	21	51	16	..	...	15	16	..	17.65	42.86	13.44	.....	.....	12.60	13.44	.....
Matapoopoo, west	1923	109	40	34	8	..	6	17	4	..	36.70	31.19	7.34	.....	5.50	15.60	3.67	.....
Matapoopoo, east	1923	2	1	1	.....	..	...	...	..	..	50	50	.....	.....	.....	.....	.....	.....
Tepatu	1923	21	1	9	5	5	1	...	..	..	4.76	42.86	23.81	23.81	4.76	.....	.....	.....
Summary	.....	251	63	95	29	5	7	32	20	..	25.099	37.848	11.554	1.992	2.789	12.749	7.968	.....
All	.....	6,164	2,506	1,442	962	15	505	704	29	1	40.655	23.394	15.607	0.243	8.193	11.421	0.470	0.016

The second class, named **fusca**, is really a composite, but it is treated as one for the sake of present convenience. The tints are more pronounced (plate 22, figs. 34-37), sometimes yellowish brown, more rarely pinkish brown. Transverse streaks of brown are displayed by some of the shells of certain colonies (plate 22, figs. 38, 39), mainly in the eastern part of the outer range, and still more abundantly in the inner series of colonies. Such shells might properly be assigned to a class to be called **strigata**; but they are here combined with the unstreaked shells for simplicity of handling.

More intense brown characterizes the shells of the third class, **fulva** (plate 22, figs. 41-43, 62). Obvious streaks are always lacking in these shells, throughout the entire range. The single sinistral shell from Oio Valley belongs to this class (plate 22, fig. 62), and the presumption is that it was produced by a parent with similar dark color. The fourth class, **phæa-purpurea**, (plate 22, figs. 44-46), is very sparsely and very locally represented. The brown color is quite deep and it also displays a purplish cast which is never equaled in **fulva** shells.

Practically without exception in the several series, the banded shells are less numerous than the plain kinds. The class called **frenata** (plate 22, figs. 47-53) possesses two revolving bands as in the groups of other species given the same designation. These stripes are rarely very deep in color or clearly defined in outline; shells like those pictured in figures 51 to 53 are exceptional rather than the average. The bands are equal in the greater number of cases; specimens like those of figures 51 and 53, with bands of different widths, are infrequent. The variant of the **frenata** pattern shown in figure 52 is displayed by two shells only, from the same colony, Irua; it may justly be regarded as a product of local mutation.

The next class, **zonata** (plate 22, figs. 54-58), is closely related to the foregoing. Certain transitional shells display a broad zone of color with deeper margins (plate 22, fig. 54), and they might be assigned with justice to the class **frenata**. Others, however, possess a solid dark zone of deeper (fig. 56) or less intense tinge (fig. 58). The sharp contrast with the general ground-color as depicted in figure 56 is exceptional. In the literature the type of shell shown in figure 58 is described as dark brown with light revolving areas; it seems preferable to treat it as one with horny-brown ground-color upon which the broad zone of darker color is superimposed.

Three-banded shells called **lyra** (plate 22, figs. 59, 60) occur in Mouaputa and Matapoopoo only. Their counterpart is abundantly represented in other primary varieties of *Partula tæniata*, as we shall see later. When the characteristic bands are compared with those of **frenata** as regards location, it is evident that they do not agree exactly; it is certain that the **lyra** type constitutes a real and independent class and that it is not merely a variant of **frenata**.

A single shell represents a final class, **bisecta** (plate 22, fig. 61). Its superimposed color is quite recognizable even though faint. The general effect is exactly like that of a boldly colored shell called **bisecta** in other species, notably in *Partula suturalis*.

The proportions of the several color classes vary from valley to valley in an interesting way (table 17). Considering first the outer series of localities, and disregarding the small series like those taken in 1907 in Atimaha and Haumi and

in 1923 in Paia, the plain classes are universally represented with the exception of **phæa-purpurea**. Their proportions are essentially similar when different annual series from a given valley are compared; when they are at variance to a notable degree, some secular change in color composition is suggested. The **frenata** class of ornamented shells is also generally present, but **zonata** is sparse and local. No factors other than those of congenital location can be invoked to account for the diversities in color composition exhibited by the several colonies.

Similar relations are displayed in the inner series of valleys. The **zonata** class is especially abundant in Fareaito. The dark **phæa-purpurea** shells came to light only in eastern Tefeo and in upper Fareaito. The single **bisecta** individual gives a particular color note to its association in Fareaito, and the few **lyra** appeared in the upper part of Mouaputa only.

The colonies of the Rotui segment differ greatly, and they also offer marked contrasts with longer established associations elsewhere. The notable points of distribution are the presence of **lyra** in Matapoopoo and of **phæa-purpurea** in Tepatu. In collective composition, therefore, the Rotui population more nearly resembles that of the inner range of valleys than that of the outer series beyond the mountain wall.

The statistical characters of the several color classes have been worked out for each of the geographical and annual series, precisely as in the case of other species. Here, however, it is not practicable to record all of the results on account of their volume. It will suffice to give the figures for representative series of the outer range, of the inner range, and of the Rotui region (table 102). While the data are self-sufficient, a brief verbal commentary may make their meanings clearer.

Within one valley area, the color classes differ among themselves so as to indicate some degree of family relationship on the part of the individuals manifesting a given form of coloration. The Oio colony of 1919 offers a favorable illustration, although exactly the same points come out in other cases. As compared with **pallida**, both the **fusca** and **fulva** classes comprise short individuals, but these two classes themselves differ markedly in proportionate measures. The single sinistral **fulva** departs widely from the dextral group of the same color in every character, so far as the average figures of the latter are concerned, but it does not stand outside of the ranges of the qualities of the dextral **fulva**; its parentage is almost as evident as its mutation in spirality.

When the classes of different annual series from the same valley are examined in detail, the relations may prove to be diverse, as shown by the illustrative figures for Vaianai. While **pallida** is almost exactly the same in the two annual series of 1907 and 1919, **fusca** is relatively longer in the first year but shorter in the second; the same may be said regarding **fulva** and **frenata**. Obviously the statistical characters of a particular group may or may not change according to the chances of mating among individuals of varying sizes and belonging to different groups.

When the collections from subordinate sections of a single valley are separately examined, not only are the numerical proportions of the color classes diverse, but a given color class may display different statistical relations to the rest of its association. In 1923 the first collection from Fareaito Valley came from the lower

section, and another series was taken from the middle zone later in the same year; the 1924 representatives were collected higher up. The figures of table 102 relating to these three series give specific illustrations of the foregoing statements.

As a rule, a color class represented by small numbers differs distinctly from the general average, as for example the **zonata** of the 1919 series from Haumi and the **phæa-purpurea** from upper Fareaito. The common distinctive colors indicate close genetic relationships and the biometric likenesses provide corroboration.

PARTULA TÆNIATA ELONGATA Pease—EMBRYONIC MATERIAL

The statistics of fecundity in *elongata* (tables 103, 104) reveal essentially the same general relations as those of another whole species like *P. mooreana* or *P. suturalis*. The material is sufficiently abundant to make the figures significant.

About 86 per cent of the adults were gravid, and they bore a total of 10,868 embryonic items, or an average of 2.46. The reproductive rate for the whole series is indicated by the average figure of 2.13 embryonic items. All of the collections were made during the calendar summer and hence there are no available comparative figures to determine whether there is a regular breeding season in this species. The 1907 series from various valleys show a somewhat lower average of fecund individuals than do those of later years. If the amount of rainfall were sensibly less in 1907 than in 1923 or 1924, this circumstance might be responsible for the differences in question; the animals remain quieter during dryer intervals and hence would not engage so actively in reproduction.

Unquestionably each colony is an independent entity, influenced solely by local conditions. The Ririofau and Fareaito collections taken in 1924 illustrate this point, as well as those of Vaianai and Paahonu which were secured on successive days in 1923.

The egg capsule is opaque throughout all of the colonies of *elongata*, with the rarest of exceptions. This point is more important than might be supposed in view of the contrasts displayed by *striolata* and by certain associations of *simulans*. The capsules are between 3 and 4 mm. in length, varying colonially to some extent. The young snails occupy practically all of the intra-capsular space before they are born.

In the matter of heredity, one basic point is clear, namely, that all of the 4985 embryonic young are dextral like their parents. It is unfortunate that there is no record in the case of the sinistral mutant from Oio, for we can not ascertain whether or not the novel character would have reappeared.

The inheritance of the distinctions of color and pattern is by no means a simple subject, because many intrinsic qualities of the material render it difficult to extract the true facts. Whereas the embryonic young of a species like *Partula olympia* develop their definitive patterns before birth, this is not the case in *elongata* or in any other variety of *Partula tæniata*. The adult shells themselves give evidence on this point. Many of the shells of the lighter colored classes, **pallida** and **fusca**, have their embryonic coils more or less deeply tinged with brown. Many of the striped adults also have brownish apical whorls, and their characteristic stripes or zonal markings emerge from this general ground-tint into separate distinctness

only on the larger coils. All such shells would be uniform brown in embryo when it would be impossible to discover what they were to become. Despite all difficulties, however, certain definite results can be obtained from the returns, which are given on their merits in table 105. It is understood, of course, that local and annual series differ greatly as regards the kinds of color types that are present and also as regards the actual proportions of their color components; nevertheless it is legitimate to bring all of the data together for comprehensive treatment.

A few individuals developed their striped patterns precociously as embryos, and they are readily assignable to their proper classes as **frenata**, **zonata** or **lyra**; some of these were the offspring of plain parents and hence offer proof that their classes are not genetically isolated from the others. The unornamented offspring fall into three groups which agree substantially with the **pallida**, **fusca** and **fulva** classes of adults, and they are named accordingly. If we consider first the young of **pallida** adults as they are recorded in the table, we find a few, as already noted, which belong definitely to striped classes. About 600, or less than one-third, are themselves actually **pallida**, while slightly more than half must be assigned to the **fusca** class. About 300 are dark enough to be denoted **fulva**. There is little doubt that the first-mentioned plain young would have remained light so as to become adult **pallida**, and it is equally reasonable to conclude that the darkest plain young would have grown into **fulva** adults. The **fusca** young present the real problem. Unknown numbers of these were destined to produce lighter colored larger whorls and they would thus be later increments to the **pallida** class. Still others might have intensified their colors to become **fulva**, or even additions to the striped classes by resolving the general color into bands or zones. The rest would have remained **fusca**. It is certain that some, at least, of the young of **pallida** parents are clearly of the same class, and that others are contributed to contrasted groups of the population. Thus some evidence is supplied that the parent class in question interbreeds with the others.

Passing to the young **fusca** adults, numbering about one thousand, we find that the majority belong to the parent class, while some are **pallida**, though the latter are proportionately fewer than in the case of the young produced by **pallida** parents. The young of **fulva** adults are mainly **fusca**, but there is a greater proportion of **fulva** young than among the offspring of **pallida** and **fusca** parents. None of the young borne by **phæa-purpurea** snails were sufficiently dark to be assigned to the same group and, incidentally, none were **pallida**. It is unnecessary to develop the argument of the preceding paragraph for these classes to show that interbreeding occurs, but it may be pointed out that the general average colors of the offspring deepen with the intensification of the parental color, as we would expect.

The young borne by **frenata** parents are plain for the most part and banded in relatively few instances; unless this color type is in process of complete submergence, many of the embryonic shells that must be classed as **fusca** and **fulva** on the basis of actual appearance are destined to develop their distinctive bands only later in life. It is significant that some **zonata** young were produced by **frenata** parents, thus proving the intercrossing of the two types.

Passing to the **zonata** class of adults, the outstanding point is the paucity of actual **zonata** young. Here again it seems sure that many or most of the unicolored young assigned to the **fusca** and **fulva** classes of offspring were destined to resolve their uniform apical tints into the zonate pattern on their larger whorls.

Despite the small number of **lyra** adults, their products are particularly valuable. The characteristic pattern actually shows precociously in one instance, and a single **zonata** also appeared. The others add nothing to the discussion.

In final summary, the proportions of the several color classes are given in table 106 for the whole embryonic population in comparison with the proportions of the same classes in the entire adult population. Assuming that there would be relatively little secular change from generation to generation in the entire series of communities of *elongata*, the differences indicate the amount of post-embryonic definition of pattern that comes about in this variety.

PARTULA TÆNIATA SIMULANS Pease—STRUCTURAL CHARACTERS

The shells now to be taken up were first described as constituting a full species, but Hartman, Garrett and Pilsbry have justly subordinated them under Mörch's name. Collectively they are a primary variety of *tæniata*, with a status equal to that of *elongata*.

The areal relations are sufficiently important to demand review at this point. The valleys of the outer range from Uufau to Pafatu are occupied by unmistakable *simulans*, to the complete exclusion of other varieties of the species, although the Uufau colonies comprise certain individuals which grade toward *elongata*. This geographical array is denoted the "outer western series." In full geographical contact with this is an inner region where also *simulans* holds sway without any admixture of other varieties of *tæniata*, and the colonies here constitute the "inner western series"; this extends from Maramu throughout the whole of the western basin of Opunohu. The low pass between Uufau and western Opunohu, dominated by the lofty peaks of Mount Mouapu and Mount Atiati, provides a definite channel of intercommunication between the two areas specified. To the eastward of the central territories now held exclusively by *elongata* lies the "outer eastern" area where *simulans* occurs, which comprises the valleys from Hotutea to Vaipua. In somewhat close proximity to the last mentioned is the "inner northern" area of Paparoa Valley, where again *simulans* is found, interpolated between the inner territory of *elongata* and the further northeastern country held by *striolata*. Recently *simulans* has gained a foothold in the central or Vaipohe division of Vaiare which it shares with *striolata;* their sparse numbers form the so-called "outer northern series." In brief, the whole territory inhabited by *simulans* falls into western and eastern areas, completely cut off from one another; the former is divisible into outer and inner portions, while the latter has three subordinate sections. As *simulans* is essentially the same in the major western and eastern regions, it is clear that it must have ranged continuously between them at some earlier time, and that it has been replaced in the central zone by *elongata*. How the replacement has been effected is a problem of much interest, which, however, is secondary to the actual facts in question.

The distinctive features of *simulans* have been recorded in the general section on *Partula tæniata* as a whole; they are well displayed by the illustrations of plate 22, figures 63 and 64, and plate 23, figures 1 to 38. As compared with *elongata*, the shell is more solid in texture and distinctly stouter, although it is not very different in absolute length. The aperture also is definitely stouter and more rounded. The lip is thicker, and the parietal tooth is more often developed. A small nodule on the columellar margin occurs almost invariably. In all of these qualities, *simulans* is sensibly intermediate between *elongata* and the group of primary varieties still remaining for examination, as demonstrated in part by the comprehensive figures of table 149.

The fundamental quality of dextral coil is universal except in two instances out of a total series of 9,417 adults, 767 adolescents, and 7,115 embryonic young, or 17,299 in all. Both of these sinistral mutants (plate 23, figs. 4 and 23) were found in Taapurau Valley—one in 1923 and the other in the subsequent year when the locality was again visited mainly to discover additional mutants. The second example was found on exactly the same bush where the first was discovered, a mile and a half inland from the sea; despite prolonged search, it had escaped observation in 1923 when apparently it had been feeding on the ground in the neighborhood. The two mutants are approximately the same in size and age and may well have been produced by the same parent, even though they display different colors; among their dextral associates are several which bore a light-colored and a dark-colored embryo at the same time. Neither of the sinistral snails was gravid, and hence there is no information concerning the persistence of the novel character, as there is in certain cases of *Partula mooreana* and *Partula mirabilis*.

Each of the quantitative and qualitative characters of *simulans* varies widely in range, as shown by the extreme examples among the illustrations and by the figures of tables 107 to 109. The shortest shell, from Vairahi, (plate 23, fig. 28), is only 12.95 mm. long, while the longest (plate 23, fig. 12) attains the extraordinary length of 19.85 mm.; this was found in eastern Morioahu Valley. The slenderest shells have an index of 46.5 per cent; representative specimen (plate 23, fig. 10) came from eastern Morioahu, but others of similar proportions were found elsewhere. The stoutest (plate 23, fig. 20) have an index of 67 per cent; the illustrated shell came from Varari. Like the shell as a whole, the aperture varies from a narrow type very like *elongata* to a rounded form with an index of 83 per cent, (plate 23, fig. 19). Finally the proportions of aperture length to shell length ranges from 46 per cent (plate 23, fig. 13) to 62 per cent (plate 23, fig. 27).

It must be borne in mind that these extremes are few in comparison with their more average associates, and that circumstances do not allow a series of illustrations which would more adequately present the features of the complete arrays of shells, among which the aberrant individuals occur. If they were taken by themselves they would undoubtedly be regarded as members of distinct varieties, or even of different species; but when the abundant intergrades are taken into account, they appear in their true relations.

It is noteworthy that exceptionally long and slender examples of *simulans*, such as those shown in plate 23, figures 10 and 13, closely resemble members of the variety *elongata*, whereas in fact they are entirely independent as the geographical data demonstrate; the two specified examples, for instance, came from eastern Morioahu which is quite remote from the areas occupied by consistent *elongata*. The short and stout examples shown in plate 23, figures 19, 20 and 23, are much like *nucleola* shells, and yet the entire associations in which they occur are clearly *simulans*; they are not immigrants of real *nucleola* nature but variants of true *simulans* which parallel *nucleola*.

The biometric data are now to be taken up in an order that begins with the general points and proceeds to more special considerations. It is understood that this order is the reverse of the actual analysis that starts with the qualities of individual associations and then combines these more comprehensively.

The first point is that all *simulans* taken together constitute a definite group within the whole species, which displays statistical differences from any other primary variety (table 149). While the ranges of the several characters are not very different from those in another primary variety, the mean values are distinctive.

When the associations of the three principal geographical regions are compared (tables 107–109), those of the outer western series of valleys prove to be collectively stouter than those of the inner western and eastern series of localities. The components of the last named differ markedly among themselves, it will be seen, and among these the immigrant groups of Vaiare are perhaps the most aberrant. It is unnecessary to comment verbally on all the details. The point of interest is that no discoverable external circumstances can be discerned which might be held responsible for the regional differences in question.

The last-stated point comes out even more clearly when the associations of one region are reviewed. In the outer western series (table 107), the collection of 1907 from Pafatu exhibits the highest figures for the absolute dimensions, while the series from the neighboring valley of Taapurau are low in the same respects, and quite as short as the distant Vaiare shells, taken collectively. In the inner western series (table 108), the associations of western Opunohu vary greatly where the outward circumstances can not be anything but uniform.

In some instances collections were made in identical valleys during both the earlier and the later years of the research; and when compared they exhibit some reduction of the absolute measures in the majority of the valleys in the outer western region (table 107). Elsewhere, however, no such reduction seems to have come about. The climatic conditions have not changed in the interim, and furthermore they are the same throughout the island. The changes in the western region are clearly spontaneous, otherwise we should expect the colonies of other territories to show similar modifications.

Within one and the same valley, the snails of the lower and the higher portions of a continuous habitat show different values for their statistical characters. The differences noted in the preceding paragraph are partly due to these circumstances, because the valleys were more deeply penetrated during later years; the case of

Hotutea is best understood in these terms. But even when the lower and higher collections were taken at the same time in a single valley slight statistical differences came to light, as in the Varari series of 1923, in Paparoa and in Maraarii (table 107).

Special consideration is required for the colonies of four valleys, namely, Uufau, Vaiare, Vaipua and Tiaorooro. The first is important because it leads to the low pass between Mount Mouapu and Mount Atiati (plates 9B, 12A) which serves as the most direct connection between the outer western and inner western territories occupied by *simulans*. The adjacent valley to the west of Uufau is Haapiti where *elongata* holds sway, although the intervening ridge is no more emphasized than the boundary on the west of Uufau; in fact, *Partula suturalis vexillum* extends continuously throughout this whole region. The biometric data for the *simulans* of Uufau (table 107) show rather definite departures from the averages of the variety at large, in the relative measures of shell proportions and aperture proportions, and the departures in question are in the direction of *elongata* features. The facts suggest that the Uufau associations are mixed *simulans* and *elongata*. Garrett held this view, as we have noted; he contended that *elongata* was a distinct species and that in Uufau hybrids occurred which masked the supposed distinctness of *simulans* and *elongata*. In my own opinion, however, the similarity of certain shells in Uufau to *elongata* does not mean a real mixture of two stocks. I regard the shells with slender stature and narrower apertures as true *simulans* which vary in the direction of the contrasted and neighboring type. Among other things, the variants do not display the attenuation of the lip which distinguishes the real *elongata*.

The shells from the middle, or Vaipohe, division of Vaiare Valley (plates 5A, B) are interesting on account of their smaller absolute dimensions, although the proportionate measures are average (table 109). Here the variety *striolata* exists in association, and *striolata* is notably smaller than *simulans*. It is possible that the two varieties have long held this territory in common and that they have fused to some extent, as Garrett held. But the numbers of *simulans* are relatively low in Vaipohe while furthermore this variety was not found in the Puutu and Faamaariri divisions of Vaiare to which it would have spread had it long existed in Vaipohe. Again, the Vaipohe *simulans* are dimensionally somewhat similar to those of uppermost Paparoa, across the mountain ridge, and this suggests their migration to Vaipohe from the inner locality. Their colors likewise ally them with the Paparoa *simulans* and distinguish them from *striolata*. My own conclusion is that the Vaipohe *simulans* are the descendants of recent immigrants from Paparoa, that they have not hybridized with *striolata*, and that their collective structural departures from the average are due to innate factors of variation which by coincidence have produced effects somewhat parallel to the qualities displayed by an associated variety.

Vaipua Valley is an open depression in a relatively dry sector of the northeast, and its inland penetration is restricted. Its vegetation is correspondingly sparse. In correlation with the greater degree of isolation of its habitable territory, its *simulans* are peculiar in their collective dimensions (table 109) and in their colonial color characters as well (plate 23, figs. 7, 14, 15).

The colony of Tiaorooro is very puzzling. The habitable area lies in an outward fork of the long dry ridge which descends northward from the lofty peak of Mount Mouaroa (plate 8, A and B); this ridge constitutes the major topographic divisor of the great Opunohu basin. Its vegetation consists of a sparse growth of low trees, and it is quite cut off from the forested areas elsewhere. The shells (table 108) are exceptionally long, wide and slender; in addition, a well-demarcated class of streaked shells exists (plate 23, fig. 5). In many ways the colony as a whole resembles an *elongata* association, but the thicker lip and columellar nodule mark it as a specialized member of the variety *simulans*.

The final structural data requiring record are those relating to the parietal tooth. Whereas *elongata* was almost universally devoid of this feature, in every colony of *simulans* a considerable number of shells have it developed to a slight degree (table 110). Very rarely it attains the size denoted by the index figure of 3, and still more rarely does it reach the fourth degree of growth. In this respect, as in so many others, *simulans* as a whole occupies an intermediate position between *elongata* and the remaining varieties of *tæniata*.

PARTULA TÆNIATA SIMULANS Pease—COLOR CHARACTERS

The affinities between *simulans* and other varieties of *tæniata*, notably *elongata* and *nucleola*, are indicated by the existence in all of similar types of coloration as well as by their structural likenesses. Hence the color classes and their names are the same as heretofore, although it does not follow that the distinguishable groups are identical in all details. One of the *elongata* classes, **bisecta**, does not recur here. The shells illustrated in plate 22, figures 63 and 64, and plate 23, figures 1 to 38, represent the types and their principal variants, but they fall far short of a complete display of the rich and varied coloration of the array they exemplify, amounting to a little less than ten thousand individuals. The full census of the color classes is given in table 18. The lightest colored shells of the class **pallida** (plate 22, figs. 63, 64, and plate 23, figs. 1-4) are usually faintly tinted, but in the northern valleys of the outer western series many are pure white, at times, as the result of decortication. A distinct order occurs within this class where the extreme apex is deeply colored with purple (plate 23, figs. 3, 4); such shells would be designated **pallida apex** if the full analysis were to be recorded. The distinctive apical feature is not restricted to the class **pallida** but recurs in others as well. Many embryonic shells present a miniature of the **apex** pattern, and such embryos are relatively more abundant among the young of **apex** parents; hence the distinction is hereditary. The colonies of the northwest comprise more **apex** individuals than those of other territories.

The class called **fusca** is delineated clearly in some valleys, but in others it grades into the subsequent one in such a way as to make the classification somewhat arbitrary. The general ground-color is light fuscous-brown (plate 23, figs. 5-11). The **apex** distinction is exhibited by some shells (plate 23, fig. 8), especially in the northwestern areas. Transverse streaks of brown may be entirely absent, or they may be shown by a few shells of certain colonies, such as those of Paparoa Valley (plate 23, fig. 6) and Vaipua Valley (plate 23, fig. 7). In both Vaipua and Tiaorooro

TABLE 18—*Partula tæniata simulans. Census of the color classes*

Series	Year	Total	Number							Per cent						
			pallida	fusca	fulva	phæa-purpurea	frenata	zonata	lyra	pallida	fusca	fulva	phæa-purpurea	frenata	zonata	lyra
Outer western:																
Pafatu	1907	308	220	62	1	...	24	1	..	71.43	20.13	0.32	.....	7.79	0.32	.....
Pafatu	1919	175	76	59	5	21	14	...	..	43.43	33.71	2.85	12.00	8.00	.....	.....
Taapurau	1923	176	78	46	9	D 35 / S 1	7	...	..	44.32	26.14	5.11	20.45	3.98	.....	.....
Taapurau	1924	793	D 383 / S 1	167	42	141	52	7	..	48.42	21.06	5.29	17.78	6.56	0.89	.....
Maatepua	1924	107	45	28	10	3	21	...	..	42.06	26.17	9.34	2.80	19.63	.....	.....
Maraarii	1907	58	28	22	.....	...	8	...	..	48.27	37.93	.....	.....	13.79	.....	.....
Maraarii	1923	476	118	186	17	...	77	78	..	24.79	39.08	3.57	.....	16.17	16.38	.....
Varari	1909	73	29	28	4	4	8	...	..	39.72	38.37	5.48	5.48	10.96	.....	.....
Varari	1923	476	136	195	18	68	59	...	..	28.57	40.97	3.78	14.28	12.39	.....	.....
Moruu	1907	90	51	28	.....	...	11	...	..	56.66	31.11	.....	.....	12.22	.....	.....
Moruu	1909	90	50	32	.....	...	8	...	..	55.55	35.55	.....	.....	8.89	.....	.....
Moruu	1923	242	90	90	29	...	27	...	..	37.19	39.67	11.98	.....	11.16	.....	.....
Uufau	1907	191	44	85	48	...	14	...	..	23.04	44.50	25.13	.....	7.33	.....	.....
Uufau	1923	129	50	40	22	...	13	4	..	38.76	31.01	17.05	.....	10.08	3.10	.....
Summary	.....	3,384	1,399	1,074	205	273	343	90	..	41.342	31.737	6.058	8.067	10.136	2.659	.....
Inner western:																
Tiaorooro	1923	43	.....	11	26	...	...	6	..	.....	25.58	60.46	.....	.....	13.95	.....
Mouaroa	1924	202	69	82	5	...	31	15	..	34.16	40.59	2.48	.....	15.34	7.43	.....
Faataofe	1923	163	24	58	58	...	23	...	..	14.72	35.58	35.58	.....	14.11	.....	.....
Faataofe	1924	46	6	22	8	4	6	...	..	13.04	47.83	17.39	8.69	13.04	.....	.....
Fanautaata	1923	125	23	40	50	...	12	...	..	18.40	32.00	40.00	.....	9.60	.....	.....
Roroie	1923	207	29	81	52	1	40	4	..	14.01	39.13	25.12	0.48	19.32	1.93	.....
Morioahu east	1923	116	7	59	36	...	14	...	..	6.03	50.86	31.04	.....	12.07	.....	.....
Morioahu	1923	319	64	95	137	...	22	1	..	20.06	29.78	42.95	.....	6.89	0.31	.....
Opunohu west	1907	99	10	50	30	3	6	...	..	10.10	50.50	30.30	3.03	6.06	.....	.....
Opunohu west	1909	247	22	123	80	9	11	2	..	8.91	49.79	32.39	3.64	4.45	0.81	.....
Opunohu west	1919	130	11	63	45	...	11	...	..	8.46	48.46	34.61	.....	8.46	.....	.....
Opunohu west	1923	213	115	47	43	5	3	...	..	53.99	22.06	20.19	2.35	1.41	.....	.....
Opunohu, below Atiati, A	1923	149	85	39	2	18	5	...	..	57.05	26.16	1.34	12.08	3.36	.....	.....
Opunohu, below Atiati, B	1923	121	63	54	.....	2	2	...	..	52.06	44.63	.....	1.65	1.65	.....	.....
Vairahi	1924	682	94	276	269	...	43	...	..	13.78	40.47	39.44	.....	6.30	.....	.....
Tupuna	1923	289	42	62	151	1	33	...	..	14.53	21.45	52.25	0.34	11.42	.....	.....
Vaiana	1923	195	20	111	24	35	5	...	..	10.25	56.92	12.31	17.95	2.56	.....	.....
Summary	.....	3,346	684	1,273	1,016	78	267	28	..	20.442	38.045	30.364	2.331	7.979	0.836	.....
Outer eastern:																
Hotutea	1907	88	17	30	11	...	15	15	..	19.32	34.09	12.49	.....	17.04	17.04	.....
Hotutea	1924	224	45	51	47	...	46	22	13	20.10	22.77	20.98	.....	20.53	9.82	5.80
Atiraa	1907	379	113	126	91	...	22	15	12	29.81	33.24	24.01	.....	5.80	3.96	3.18
Atiraa	1924	227	70	78	45	...	18	10	6	30.84	34.36	19.82	.....	7.93	4.40	2.64
Vaipua	1924	124	6	11	107	...	...	...	..	4.84	8.87	86.29	.....	.....	.....	.....
Summary	.....	1,042	251	296	301	...	101	62	31	24.088	28.407	28.887	.....	9.639	5.950	2.975
Inner northern:																
Paopao north	1923	251	58	58	108	...	13	8	6	23.11	23.11	43.02	.....	5.18	3.19	2.39
Paparoa (low)	1907	220	66	40	97	8	2	1	6	30.00	18.18	44.09	3.64	0.91	0.45	2.73
Paparoa (high)	1909	85	9	13	48	...	9	4	2	10.59	15.29	56.47	.....	10.59	4.71	2.35
Paparoa (high)	1919	44	6	12	20	...	1	...	5	13.63	27.27	45.45	.....	2.27	.....	11.36
Paparoa (low)	1919	663	87	122	425	1	15	1	12	13.12	18.40	64.10	0.15	2.26	0.15	1.81
Paparoa (high)	1923	125	17	25	52	1	20	...	10	13.60	20.00	41.60	0.80	16.00	.....	8.00
Summary	.....	1,388	243	270	750	10	60	14	41	17.507	19.452	54.034	0.720	4.323	1.008	2.955
Outer northern:																
Vaiare Vaipohe	1919	91	12	21	42	...	8	2	6	13.19	23.07	46.15	.....	8.79	2.20	6.59
Vaiare Vaipohe	1924	166	51	54	47	...	6	5	3	30.72	32.53	28.31	.....	3.61	3.01	1.81
Summary	.....	257	63	75	89	...	14	7	9	24.513	29.182	34.630	.....	5.447	2.723	3.502
All	.....	9,417	2,640	2,988	2,361	361	785	201	81	28.034	31.729	25.071	3.833	8.336	2.134	0.860

a definite group of such shells exists, without intergrades; this group really deserves full class status as **strigata**, but in the present brief account they are subsumed under the class **fusca** as an order.

Considerable variation occurs among the **fusca** shells; some are pale lemon-yellow, while others are light orange-brown (plate 23, fig. 10) or pale brownish pink (plate 23, fig. 11). Shells of these kinds are particularly frequent in the Morioahu region of the inner western series as well as in Vaiana and Tupuna. Doubtless some intercommunication between these areas has taken place across the forested lowlands of the Opunohu basin.

Darker brown shells form the class **fulva** (plate 23, figs. 12–18). They range from individuals only slightly deeper in tint than **fusca** to very dark brown. The apical purple tinge is exhibited by some shells in certain colonies (plate 23, fig. 18). A very few shells were found, and in widely separated localities, which displayed a curious red alteration of the brown (plate 23, fig. 17); this novel character is also shown by very rare embryos, and hence it is actually an innate quality, suggestive of a mutation. Transverse markings of sharp or vague nature and of deeper color are sometimes shown (plate 23, figs. 14, 15), but it is not desirable to establish a separate group for them.

The class called **phæa-purpurea** (plate 23, figs. 19–24) offers a sharp contrast with the foregoing in practically every valley where it occurs, but sometimes intergrades connect it with **fulva**. The deep and characteristic colors require no emphasis. One of the novel sinistral shells from Taapurau belonged to this class (plate 23, fig. 23).

Passing to the banded classes, **frenata** deserves first notice on account of its general prevalence. The distinctive stripes are usually light brown and somewhat vague on a pale ground-color (plate 23, figs. 25–27); sometimes both the stripes and the background are deeper (plate 23, fig. 29). Very rarely the colors are purple-brown (plate 23, fig. 30). The **apex** character is manifested in the colonies of certain valleys (plate 23, fig. 26). A basal band sometimes occurs (plate 23, figs. 26, 28) but it is less consistent than the two primary stripes which give the class its name, and it does not convert the pattern into the **lyra** type when it does occur.

Shells with a broad median girdle constitute the **zonata** class (plate 23, figs. 31-35). As in **frenata**, the usual color of the ornamentation is brown (plate 23, fig. 31) and the deeper tints (plate 23, figs. 32, 33, 35) are rare. Many variants of this pattern are found, of which only two are illustrated (plate 23, figs. 34, 35).

The last class is **lyra** (plate 23, figs. 36-38), whose differences from **frenata** are obvious at a glance. Only the upper stripes coincide. This class is found only in the eastern territory occupied by *simulans*; this fact is interesting in view of the occurrence of **lyra** among *elongata* only in the east, and of the prevalence of **lyra** among *striolata* of the extreme northeast.

A review of the census (table 18) finds many differences among the several colonies as regards the number and kind of color classes present as well as in the proportions of the various components in their respective associations. As we have noted, **lyra** is entirely absent from the outer and inner western series. The broadly banded shells are far more abundant in the east than in the west, when they

occur in greater numbers in the higher portions of the valleys than near the coast. The **frenata** class is universally present except in the isolated valley of Tiaorooro. Like **zonata**, **phæa-purpurea** is sporadic in its occurrence, with marked differences in frequency even in contiguous valleys such as Vaiana and Tupuna. When all of the facts are assembled, the resulting conclusion is that the internal factors of hereditary determination are the only ones which operate to produce the manifest color patterns of an individual and that the collective color composition of an association is likewise the product of genetic factors solely.

The final task in the present connection is to discuss the significance of the statistical characters of the color classes. The complete record is not given for all of the material on account of the prohibitive bulk of the returns. It will be sufficient to consider the data relating to representative collections taken in the different geographical areas inhabited by *simulans*; the figures are given in table 111.

A given color class may differ from the community average in one way in the upper part of a valley while it differs in the opposite way in the lower section of the same valley; in the 1923 series from Maraarii, **pallida** is distinctly larger in the lower area, while **fulva** presents the reverse relation. It is true that the differences are not always significant when judged in terms of their probable errors.

No consistent relation is exhibited by a particular class throughout a wide area comprising several valleys. Each community is a genetic entity, and there is no correlation between a given type of coloration and distinctions of size or form.

The sporadic individuals forming a small color group within their community often display collective statistical differences from the average; this is to be expected in view of their presumably closer relationships. The **lyra** class of Atiraa, 1907, and of Paparoa, 1919 (table 111), illustrate this point.

In general the facts support the view that external circumstances do not participate in the control of such biometric distinctions as may characterize the several color classes.

PARTULA TÆNIATA SIMULANS Pease—EMBRYONIC MATERIAL

The present primary variety agrees closely with others of its species in fecundity (tables 112, 113). About 80 per cent of the adults were found to be gravid and on the average they bore approximately 2.4 embryonic items apiece. The reproductive rate for all adults is low as indicated by the average figure of 1.9 items; but doubtless this is compensated for by continuous breeding throughout the year.

The significant figures vary greatly throughout the table, and they give no indication of a definite breeding season; but the collections were made during the calendar summer in all cases, and nothing is known about the breeding conditions at other times of the year. It is known that the number of continuous moist days is the major factor of active movement and therefore of active mating; humidity and rainfall vary much from place to place during a single week, and also from year to year for a given month, and their fluctuations would be sufficient to account for the variations in the returns. After being fertilized, the snails seem to produce continuously for a time, as the summary figures of table 113 indicate.

One very interesting instance of "twins" came to light in a snail taken in Taapurau Valley in 1924, where two well-advanced embryos were enclosed in a single capsule. As their colors were different, they were obviously produced by two eggs, and not by separated portions of a single zygote. They are not "identical twins." Similar cases appeared in *Partula mooreana* and *Partula aurantia*.

The egg capsules are slightly smaller than those of *elongata*. They vary from about 2.9 mm. to 3.2 mm. in length, and from 2 mm. to 2.3 mm. in width. Throughout the outer western and inner western series the egg-capsules are opaque with the rarest of exceptions; but the eastern colonies present marked contrasts in this respect. Some of the capsules are opaque, some are entirely transparent, and others are intermediate or cloudy (table 114). All three kinds are sometimes found in a single gravid individual. When we reach the variety *striolata* we shall find that transparency of the capsule is practically universal. Hence the eastern colonies of *simulans* provide an interesting transition from the conditions shown in *elongata* and western *simulans* to that of *striolata*. The proportions of opaque, cloudy, and clear capsules are strangely different among the several eastern colonies of *simulans*, and they also vary from one to another part of the same valley, as in Paparoa. At first it might seem that some mineralogical condition of the northeastern part of Moorea, such as a scarcity of lime, might be held for the deficiencies in capsular impregnation, but such a supposition is untenable. Capsules differ, not only in different individuals in the same situation, but even in the same brood-pouch of a single parent, as we have noted. Furthermore, the accompanying species, *Partula suturalis* and *Partula exigua*, exhibit no parallel deficiency. The explanation must be sought in internal factors, for these are certainly responsible when two species existing side by side differ consistently in the transparency or opacity of their egg-capsules, like *Partula otaheitana* and *Partula hyalina* in Tahiti, or *Partula gibba* and *Partula fragilis* in Guam.

The embryonic young attain a length of about 3 mm. before they become free. The protoconch is noticeably stouter than in *elongata*. Very few embryos gain their final forms of coloration before birth, and in this respect *simulans* is much like *elongata*. The statistics of apparent heredity are given in summary for all of the *simulans* colonies (table 115), even though color composition varies so greatly throughout the whole list of associations. However, differences exhibited by the main geographical divisions of the variety are taken into account in the comparison of adult and embryonic representations of the several color classes (table 116).

Among the more important points to be noted, the first is that embryonic young of *simulans* are prevailingly light brown, although most of them are destined to assume other forms of coloration in later life. Offspring of **pallida** parents are more frequently **pallida** than are the products of darker colored parents. By similar principle, the offspring of **fulva** group themselves toward the darker end of the scale. While no embryo produced by a **phæa-purpurea** parent was recognizable as a member of this class, the majority showed the darkest shades of brown; pre-

sumably, therefore, the deep purple character of this class is hereditary even though it is not manifested in the earliest stages.

We may justly assume that color composition is changing very slowly, if at all. The excess of **fusca** young in the embryonic population over the proportion in the adult series is an index of the amount of later diversification on the part of the first named. The deficiency of embryonic young of a type like **frenata** or **phæa-purpurea**, in a similar comparison, indicates the extent to which other classes contribute to the type in question by post-embryonic modification of color.

A final point is that the purple apex, which is an attribute of definite components of colonies in the outer western series, is hereditary in the sense that it recurs in a greater proportion of the young borne by parents possessing the character than it does among the embryonic products of snails devoid of the apical color.

The banded forms of coloration are exhibited recognizably by very few individuals, but fortunately there are some precocious individuals which give evidence that the color classes interbreed. Several instances were found among the unbanded classes where light and dark young were present at the same time in a given parent. The most significant among these are the "twins" earlier noted. Interbreeding on the part of the unstriped types seems also to be unrestricted.

PARTULA TÆNIATA STRIOLATA Pease—STRUCTURAL CHARACTERS

The present variety offers many contrasts with the two varieties already described, both in geographical respects and in morphological characters. Whereas *elongata* and *simulans* occupy considerable areas of the coastal and inner regions of Moorea, *striolata* occurs in a compact, unified section at the extreme northeast of the island. Its area of habitation is invaded by another variety of *tæniata*, namely *simulans*, only in the central or Vaipohe division of Vaiare Valley. Sparse numbers of *Partula exigua* exist in association throughout the whole of its area; otherwise its accompanying species are *Partula suturalis* in Vaiare, Tepu and Maharepa, and *Partula aurantia* in Vaiare and Paraoro Valleys.

In its structural respects, *Partula tæniata striolata* departs widely from *simulans*, and *a fortiori* from *elongata*, while in the nature of its departures it aligns itself with the remaining varieties, *nucleola*, *spadicea* and *propinqua*, which occupy the middle and the western elements of the trident projections of Moorea to the northward. Garrett's comments on the resemblances between *striolata* and *nucleola* are to be recalled in this connection. The earlier discussion has cited the reasons for the belief that *striolata* and the other northern varieties best preserve the more original qualities of *Partula tæniata* from which *simulans* and *elongata* have departed to a lesser and to a greater degree respectively.

The comprehensive statistical descriptions of table 117 and the illustrations of plate 23, figures 39 to 64, define and portray the structural characters of this variety. The shells are generally shorter than those of *simulans* in absolute range as well as in average value. But the most obvious differences consist in the stoutness of the shells and in their solid texture. The aperture is small. The lip is also very much thickened and rounded; the prominence or notch near the columellar

insertion is usually quite pronounced, but not invariably so. These morphological distinctions are accompanied by a peculiarity of coloration in the way of transverse ashen streaks, to be duly described at a later point.

The full colonial figures (table 117) vary far less throughout the range of *striolata* than do the corresponding descriptive constants for the previously described varieties. The present variety is much more consistent. Where *striolata* exists in company with *simulans* in Vaiare-Vaipohe, the proportions of the shell and of the aperture are lower than elsewhere, and they approach the figures for the associated form. To what extent hybridization may be held accountable is uncertain; the facts are merely recorded at this juncture.

One general point may be made here, namely, that the peculiarities of *striolata* as a whole, when compared with those of its ally, *simulans*, are not duplicated in any degree by the associated species, *Partula suturalis*, *P. aurantia* and *P. exigua*. Hence there is nothing to indicate that environmental factors as such are responsible for the distinctions in question.

All of the *striolata* secured during the present research are dextral, whatever their ages. The total number is well over eleven thousand, and there are perhaps several hundred more in the museum collections of the world, and they are also dextral. This being so, it is interesting to recall that the *Partula suturalis* of the northeastern region are mixed in Vaiare and exclusively sinistral in Tepu and Maharepa, while sporadic reversed mutants of *Partula aurantia* were found in the Paraoro sector where *striolata* abounds. These facts add their weight to the conclusion that the direction of coil is exclusively determined by innate factors.

The usual aspect of *striolata* shells is well shown by the majority of the illustrated specimens (plate 23, figs. 39-64). The extreme variants are striking. In length they range from 12.35 mm. (plate 23, fig. 44) to 18.05 mm. (plate 23, fig. 47); the latter shell, from Paraoro, is equaled by others from Vaiare, but in its own valley it is a "giant" in the sense that it is much larger than any others of the place. The proportions of the shell range from 51.5 per cent to 70.5 per cent (plate 23, fig. 45). The aperture may be long and slender (plate 23, fig. 42), thus causing some resemblance to *simulans*, or very short and broad, with an index of 86 per cent (plate 23, fig. 46).

It must be understood that the extreme examples cited are few in number as compared with the great bulk of the population; almost without exception the curves are continuous and regular between the limits recorded numerically for the several associations (table 117). Were it not for the greater mass of shells which approximate to the average, grading in decreasing numbers away from the average toward the extremes, it would seem scarcely credible that the unusual individuals belonged to the same variety, or even to the same species.

The parietal tooth is virtually ignored by earlier commentators. While it never gains a high degree of development, it appears as a weak feature in a considerable body of the population (table 118); the descriptive average figures run somewhat uniformly throughout the whole range.

When collections were obtained from the same valley in earlier and in later years (table 117), the absolute dimensions proved to be generally smaller for the series of the second period; the data for Vaiare-Puutu, Tepu, Maharepa, and middle Paraoro are especially clear. While secular changes are thus indicated with some probability, another consideration enters. Usually the valleys were more deeply penetrated during the later years of field-study, and hence the lower dimensional figures for the shells then collected mean that the upper components of a valley association were smaller than those dwelling nearer the coast. The case of Vaiare-Vaipohe is one where this is certainly true, for the series of 1924 came from the lower reaches of the valley, while that of 1919 was taken far up near the divide. But the two series from middle Paraoro were actually collected from exactly the same sector of the valley, and they at least attest the fact that colonial changes had come about with the passage of time.

PARTULA TÆNIATA STRIOLATA Pease—COLOR CHARACTERS

Whatever their differences in depth of tint or in pattern, the shells of *striolata* are clearly distinguished from those of other varieties by peculiar light or ashen streaks, which have been noted and emphasized by earlier authors. These streaks are sometimes mere pigmental interruptions of the general coloration, when they recall the marks of *Partula suturalis strigosa*. But in the majority of the shells there are transverse markings in the way of lines etched into the surface. Darker types display the latter more clearly than light colored shells.

The color types are the same as in the earlier described varieties, although some do not correspond exactly. The lightest shells designated **pallida** (plate 23, figs. 39-41) are never as white as the palest members of the same class in *elongata* or *simulans* but collectively they bear the same relation to their associates. In Vaiare-Vaipohe, however, this class does approach more nearly to its counterpart in *simulans*, precisely as the structural characters of all *striolata* in the same locality approach those of the associated variety. The classes of **fusca** (plate 23, figs. 42-46) and **fulva** (plate 23, figs. 47-51) agree quite well with the divisions of other varieties bearing the same names. Exceptional examples of **fulva** which are reddish brown (plate 23, fig. 48) occur sporadically as they do in certain colonies of *simulans*. When the class **phæa-purpurea** is present, it is always clearly set apart from the darkest extremes of **fulva** (plate 23, figs. 52-54); it is in this class that the transverse etched markings are best displayed.

There is nothing peculiar about the **frenata** (plate 23, figs. 55, 56) and **zonata** shells (plate 23, figs. 62-64). Three-banded shells of the class **lyra** (plate 23, figs. 57-61) are far more abundant among *striolata* than in any other variety, and they are especially prevalent in Maharepa Valley. With his limited material, Pease was constrained to call this type "rare," but Garrett recognized its greater abundance. Noteworthy variants of **lyra** occur in Faamaariri, Paraoro and Farehotu, which expand the upper and lower stripes to the sutural and basal limits, respectively (plate 23, figs. 60, 61); were the present analysis carried to its full development, these shells would be assigned to a distinct color order. Their appearance in three

separate localities is important, as it indicates the same kind of mutational change by entirely independent procedure. Another apparent mutation occurs where the colors are deep purple-brown (plate 23, fig. 61).

The several associations of *striolata* are quite different in color composition, as the census shows. The kinds of color classes present differ, and their proportions in the population also vary. The dark class, **phæa-purpurea**, is notably absent from the sector from Tepu to Maharepa; **frenata** is very local; **zonata** is not so rare but is sporadic in its appearance. We have noted above that **lyra** is universally present and relatively abundant. The Maharepa population does not seem to have changed much in its color composition from 1907 to 1923; but the series from Tepu appear to be different, and a real secular change is suggested. It is scarcely necessary to repeat the argument concerning the value of all of the above facts for the problem of hereditary causation as opposed to environmental participation in determining the individual and colonial qualities of coloration.

TABLE 19—*Partula tæniata striolata. Census of the color classes*

Series	Year	Total	Number							Per cent						
			pallida	fusca	fulva	phæa-purpurea	frenata	zonata	lyra	pallida	fusca	fulva	phæa-purpurea	frenata	zonata	lyra
Vaiare Puutu	1907	343	49	171	92	2	..	1	28	14.29	49.85	26.82	0.58	....	0.29	8.16
Vaiare Puutu	1919	236	34	130	49	1	..	1	21	14.41	55.08	20.76	0.42	....	0.42	8.90
Vaiare Vaipohe	1919	35	4	6	21	...	..	3	1	11.43	17.14	60.00	....	....	8.57	2.86
Vaiare Vaipohe	1924	130	16	47	61	...	2	2	2	12.31	36.15	46.92	....	1.54	1.54	1.54
Vaiare Faamaariri	1919	297	35	139	98	2	..	1	22	11.78	46.80	33.00	0.67	....	0.34	7.41
Vaiare Faamaariri, A	1923	575	22	146	355	4	3	..	45	3.83	25.39	61.74	0.69	0.52	....	7.83
Vaiare Faamaariri, B	1923	525	31	209	228	1	..	1	55	5.90	39.81	43.43	0.19	....	0.19	10.48
Vaiare Faamaariri	1924	607	65	294	152	56	..	5	35	10.71	48.43	25.04	9.22	....	0.82	5.77
Tepu	1907	70	16	33	13	...	..	1	7	22.86	47.14	18.57	....	....	1.43	10.00
Tepu	1919	421	67	172	134	...	..	..	48	15.91	40.85	31.83	....	....	....	11.40
Temæ	1923	499	48	134	241	...	..	..	76	9.62	26.85	48.30	....	....	....	15.23
Maharepa	1907	583	65	289	129	...	..	..	100	11.15	49.57	22.13	....	....	....	17.15
Maharepa	1923	889	106	351	298	...	..	..	134	11.92	39.48	33.52	....	....	....	15.07
Oroau	1923	156	56	59	26	9	..	..	6	35.90	37.82	16.66	5.77	....	....	3.84
Farehotu	1924	459	74	215	76	32	..	..	62	16.12	46.84	16.56	6.97	....	....	13.51
Paraoro middle	1909	259	24	121	91	8	..	1	14	9.27	46.72	35.13	3.09	....	0.39	5.40
Paraoro middle	1923	142	19	64	44	9	..	1	5	13.38	45.07	30.98	6.34	....	0.70	3.52
Paraoro south	1923	358	88	131	103	22	..	2	12	24.58	36.59	28.77	6.14	....	0.56	3.35
All	.....	6,584	819	2,711	2,211	146	5	19	673	12.44	41.17	33.58	2.22	0.08	0.29	10.22

Passing now to the final stage of biometric analysis, the color classes of all *striolata* associations are defined in terms of the mean values of their several characters (tables 119, 120)—a record that may possess greater value after the lapse of years. The color classes bear different statistical relations to one another when the colonies of even contiguous valleys are compared, and the color classes of a later year's collection are not always interrelated as are those of an earlier series from the same locality. It is true that the statistical differences are rarely large when estimated in terms of their probable errors; but the general result remains that color and structure vary from place to place and from year to year as the chances of interbreeding may determine. It would be purely gratuitous to suppose that a secular or a regional difference displayed by the shells is to be accounted for by differences in external circumstances.

PARTULA TÆNIATA STRIOLATA Pease—EMBRYONIC MATERIAL

When the full records of fecundity are assembled (tables 121, 122), *striolata* proves to be much like the earlier described varieties. Again about 80 per cent of the adults were gravid. The average number of embryonic items contained within the bearing individuals is about two and a half.

One outstanding point of difference is the clear nature of the capsule. In *elongata* this was always opaque, while in the eastern and northern colonies of *simulans* the capsules were opaque, vaguely clouded, or transparent, in varying proportions. Here in *striolata* only a few cases were found where there was a slight clouding of the membrane, and none were discovered which were fully impregnated. The full statistics are not tabulated, in view of the simplicity of the situation.

An analysis of the statistics of apparent heredity (tables 123, 124) leads to the same conclusions as heretofore. The young of **pallida** parents grade toward the lighter end of the scale, those of **fulva** origin are distinctly darker with greater frequency, and the same is true of the offspring borne by **phæa-purpurea** adults. None of the latter are actually deep purple-brown, but they are collectively darker than the young of other plain classes.

As most of the adult shells of *striolata* display some darkening of the apical whorls, it is inevitable that the greater number of the embryonic young would be brownish in color. A few of these are destined to become lighter, but only a few if we judge by the difference of 2 per cent between embryonic and adult **pallida**. More of the young with the brownish or **fusca** character would be contributed to the adult classes of **fulva**, **phæa-purpurea** and banded types.

The **lyra** pattern is displayed by a larger proportion of embryonic shells than in the case of another variety. Double-striped **frenata** young are missing among the embryos, and hence the characteristic form of coloration is a late development in this variety. The one anomaly is the greater proportion of **zonata** young as compared with similarly marked adults. Probably many of the former were destined to provide increments to the **lyra** class as the broad band of the protoconch became divided on later-added whorls.

In summary, the facts indicate that the color distinctions are generally hereditary, and that cross-breeding takes place indiscriminately. The precocious **zonata** young among the offspring of **fusca** and **fulva** parents are especially noteworthy in the second connection. Many instances occurred where banded young and plain young of different tints were present within a single parent at the same time. Such cases confirm both of the summary statements regarding the significance of embryonic coloration.

PARTULA TÆNIATA NUCLEOLA 'Pease' Garrett—STRUCTURAL CHARACTERS

The variety now to be described is closely related to *striolata* in its patent characters, although its area is widely distant. The northern part of Moorea presents the form of a trident whose central member is the massive mountain of Rotui, while the lateral members consist of the terminal heights of the main crescent of mountains; the bays of Opunohu and Paopao accentuate the separation of the

northwestern, the Rotui, and the northeastern uplands. Our present variety occupies the first named, so far as this is habitable at all.

According to Garrett, Pease named *Partula tæniata nucleola* as a full species in manuscript without giving a formal description. Garrett's own basic account specifies some of the distinctions, but the fundamental diagnosis is that of Pilsbry, quoted in the general section of this chapter. Pilsbry also expresses his opinion that the *nucleola* "is probably more primitive than the typical *tæniata*," meaning by the last phrase the type indicated in Mörch's original description. In point of fact, *nucleola* and its close allies—*spadicea* and *striolata*—are properly designated more typical in the sense that they have retained more of the characters of the original stock of the species, from which *simulans* and *elongata* have departed. My own opinion accords with that of Pilsbry, as well as with his view that *nucleola* "stands very close to *P. filosa* of Tahiti"; the relationship in question is a telling fact in favor of a prior land-connection between Tahiti and Moorea, broken by subsequent subsidence.

The valley of Faatoai constitutes the headquarters of *nucleola* (plates 4A, 10A, B). The contiguous area of Urufara, which opens out on to the shores of Opunohu Bay, is also occupied by this variety in large numbers. A third area is Aareo Valley, which is a small and shallow ravine between Urufara and the lowlands of Opunohu Valley. In geographical relations, Aareo and Urufara abut upon a ridge which separates them from the inner areas of Vaiana, Tupuna and Vairahi. Faatoai articulates with Vairahi on the south and with the array of outer localities from Varari to Pafatu on the west. All of these other areas are inhabited by *simulans*. Urufara and southeastern Faatoai adjoin. The eastern slopes of the hills between the mouth of Urufara Valley and Faatoai Valley are indented by the wedge-shaped open valley of Vaitapi, where also *nucleola* occurs, but where the dryer conditions render the region unsuitable for *Partula suturalis*, elsewhere an inhabitant of the northwestern part of Moorea. The final area of Poararua is little more than a shallow depression on the eastward face of the massif between Urufara and Vaitapi. The extreme northwestern sector is too dry for Partulæ. The areal relations are essential, in general and in particular, for an analysis of the structural qualities of *nucleola*.

Nearly six thousand adults were secured throughout the whole territory in which the five valleys lie. The statistical characters for each local and annual series are given in full (table 125), and in condensed form as well (table 126). The illustrations of plate 24, figures 1 to 25, display the qualities which may not be numerically defined.

All of the measurable characters vary far more widely in range than they do in *striolata*, *simulans* and *elongata*. The shortest individual (plate 24, fig. 1) is only 12.25 mm. in length; this is equaled by a specimen of *striolata*. The longest shell (plate 24, fig. 7), with a length of 20.15 mm., is a "giant" within its own valley of Poararua, and it is the longest specimen of all *tæniata*; a few *elongata* and *simulans* approach it, but they do not actually attain its extraordinary dimensions. In proportions the shell varies from 68 per cent (plate 24, fig. 5) to 49 per cent (plate

24, fig. 6). The aperture also varies greatly and not always in correlation with the whole shell, although the giant from Poararua does happen to possess the longest aperture. In proportions, the aperture ranges from 65 per cent (plate 24, fig. 9) to 87 per cent (plate 24, fig. 2). The proportion of the long axis of the aperture to that of the whole shell varies from 45 per cent (plate 24, fig. 10) to 60 per cent.

The extreme examples described in the foregoing paragraph differ so greatly that even with the array of more average specimens of the plate their assignment to one and the same variety may seem somewhat forced. But they are only unusual and selected members of large representative collections from their respective valleys; the frequency polygons of variation for their respective characters are relatively smooth and normal, and all possible intergrades connect them. They are not abnormalities and they are not examples of different varieties.

The descriptive figures of tables 125 and 126 need not be reviewed *in extenso*, but certain significant points may be mentioned. In Garrett's account of *simulans* he says that the colonies of western Opunohu intergrade with the *nucleola* of the headquarters valley, Faatoai. This statement is not borne out by the specific figures of the tables. It is true that the *simulans* of western Opunohu are smaller than elsewhere, but the critical proportions do not definitely approach the figures for the Faatoai *nucleola*.

It is otherwise with the relations of the Aareo and Urufara colonies. The comprehensive statistics of table 126 show a consistent progress from the less compact shells of Aareo, with slender apertures, through the Urufara, Poararua and Vaitapi associations to the typical *nucleola* of the Faatoai region. Specifically, the proportions of the shells in this sequence are 56.81, 57.18, 58.31, 58.98 and 59.99 per cent; the proportions of the aperture are 73.31, 74.80, 75.77, 86.56 and 78.31 per cent. While the proportion of aperture to shell in length varies somewhat, it remains sensibly the same throughout the series of valleys. As a corroborative detail, it appears from table 125 that the southern subdivisions of Urufara bear colonies which are more like those of Aareo, while the sub-colonies for the northern part of Urufara more closely resemble the Faatoai *nucleola*.

The transitional relations thus expressed are important in several connections. Throughout this whole chapter it is contended that *nucleola* and the other short compact varieties are older than *simulans* and older still than *elongata*. It is held that these compact varieties have gradually become restricted to the prongs of a geographical trident as the variety called *simulans* gained its distinctions and spread more extensively from its center of origin. The *modus operandi* of the replacement of *nucleola* by *simulans* is a puzzling problem which requires much fuller treatment than is possible at this juncture; it is the same kind of a problem which arises in critical colonies of *Partula suturalis* like those of Uufau Valley and Vaiare Valley, where a wave of dextrality appears to be following a flood of earlier sinistral expansion. One opinion only will be offered here, namely, that the replacement under discussion does not occur by an actual migration involving numerous snails, possessing the newer qualities, into the further territory; it seems to come about by the spontaneous origin of the novelty or change in the

more remote territory. Obviously this whole question requires more analysis of the actual facts than is permissible in the present outline.

The colonies of different geographical sections vary greatly (tables 125, 126) but without any discoverable relation to external circumstances. The low average figures for the direct dimensions of the colonies of Taatuapæ and Vaipapa within Faatoai mean only that the genetic factors are different in these localities. The range of variation may go almost as high as in another situation, and associates like *Partula suturalis* exhibit no reduction of their absolute measures; were the environment *per se* really responsible, the facts would be otherwise.

Secular changes seem to have come about during the years of the investigation. Again the Urufara collections provide clear examples. The 1907, 1909 and the "B" series of 1923 came from the same subdivision of the valley; their descriptive figures differ in such ways as to indicate colonial change between the earlier years and the later. The 1907, 1909 and 1919 series from Faatoai were taken in the Terahimaue subregion, where still another collection was made in 1923. Real fluctuations of the measurable characters are clearly shown. It appears that no climatic alterations have transpired, and hence the observed differences must be referred to internal direction.

The tooth is weakly developed in *nucleola* (table 127) as in other varieties of *tæniata*. It is usually only a low trace if it appear at all; seven shells displayed a tooth of the third degree of development, while a single specimen had one of the fourth degree.

PARTULA TÆNIATA NUCLEOLA 'Pease' Garrett—COLOR CHARACTERS

In a general way the color composition of *nucleola* is more like that of *simulans* than of *striolata*. This really means that *simulans* has retained more of the original qualities of coloration possessed by the ancient stock as represented by *nucleola*. While *striolata* is also primitive in form, it has changed in some of its features of color.

The full census of the color classes of *nucleola* is given in table 20, and representative specimens are shown in plate 24, figures 1 to 25. With nearly seven thousand adults in hand, it is obvious that only the prominent types and variants can possibly be illustrated.

The shells of the **pallida** class (plate 24, figs. 1-4) are usually very light in tint, if indeed they are not clear chalky white; no member of this class was found with a purple apex such as occurs locally in **pallida** of *simulans*. The **fusca** (plate 24, figs. 5-8) and **fulva** (plate 24, figs. 9-13) shells are not noteworthy, although in some valleys, notably Urufara, some exist which possess transverse streaks like those of some members of the same classes among *simulans* and *elongata*; we shall see that such streaks become much more pronounced and more general in *spadicea*. The **phæa-purpurea** class (plate 24, figs. 14, 15) is typical and clearly set apart from the darkest among the **fulva**.

The ornamented shells fall into the same three classes as heretofore, namely, **frenata** (plate 24, figs. 16-18), **zonata** (plate 24, figs. 19-21), and **lyra** (plate 24, figs.

22-25). Ordinarily the revolving stripes and zones are fulvous in color, but occasional and local variants occur where the tint is deep brown (plate 24, fig. 18) or even purple-brown (plate 24, fig. 21). One variant of lyra is particularly interesting, in which the deep colors spread from the lateral bands to the suture and to the base respectively; this type occurred only in Mave.

The census shows how the several series of *nucleola* vary in color make-up in the same ways as in other varieties. The three lightest classes of plain shells are universally present, and phæa-purpurea is also generally present except in the Aareo series and in a small collection from Vaitapi. But the numerical proportions differ greatly, and without any apparent relation to external circumstances; even when the environment must be the same, as in the three divisions of southern Urufara, the figures are different. The lyra class is almost invariably represented, but again by varying percentages. The other classes of striped shells are local and irregular; in this connection we may note the correspondence between the Faatoai collections of 1907, 1909 and 1919 with the 1923 series from Terahimaue and Mataitau.

TABLE 20—*Partula tæniata nucleola. Census of the color classes*

Series	Year	Total	Number							Per cent						
			pallida	fusca	fulva	phæa-purpurea	frenata	tæniata	lyra	pallida	fusca	fulva	phæa-purpurea	frenata	tæniata	lyra
Aareo	1909	54	4	23	21	..	*	3	3	7.47	42.59	38.89	.....	.....	5.55	5.55
Aareo	1919	78	9	29	32	..	*	*	6	11.54	37.18	41.02	.....	2.56	.....	7.69
Aareo	1923	177	27	47	76	..	..	9	18	15.25	26.55	42.94	.....	.....	5.08	10.17
Urufara	1907	394	20	145	170	42	10	..	7	5.07	36.80	43.15	10.66	2.54	.....	1.78
Urufara	1909	296	21	79	130	49	12	..	5	7.09	23.69	43.92	16.55	4.05	.....	1.69
Urufara south, A	1923	121	19	19	54	20	7	*	..	15.70	15.70	44.63	16.53	5.78	1.65	.....
Urufara south, B	1923	918	58	303	457	38	10	30	22	6.32	33.01	49.78	4.14	1.09	3.27	2.39
Urufara south, C	1923	219	13	24	122	48	12	..	..	5.93	10.96	55.71	21.92	5.48	.....	.....
Urufara north	1923	162	22	41	64	34	*	1	..	13.58	25.31	39.50	20.99	.....	0.62	.....
Urufara north central	1924	104	7	15	44	34	..	..	4	6.73	14.43	42.31	32.69	.....	.....	3.84
Poararua	1923	454	68	180	198	7	..	..	1	14.98	39.65	43.61	1.54	.....	.....	0.22
Vaitapi	1923	120	2	36	81	1	..	..	..	1.66	30.00	67.50	0.83	.....	.....	.....
Vaitapi	1924	60	*	14	44	..	..	..	..	3.33	23.33	73.33	.....	.....	.....	.....
Faatoai	1907	269	50	136	69	6	..	4	4	18.59	50.56	25.65	2.23	.....	1.48	1.48
Faatoai	1909	317	64	176	56	14	..	1	6	20.19	55.52	17.67	4.42	.....	0.31	1.89
Faatoai	1919	886	107	457	253	48	1	7	13	12.08	51.58	28.55	5.42	0.11	0.79	1.47
Faatoai—Mave	1923 1924	338	93	116	88	36	..	..	5	27.51	34.32	26.03	10.65	.....	.....	1.48
Faatoai—Mave upper	1923	143	23	59	38	18	..	..	5	16.08	41.26	26.57	12.59	.....	.....	3.50
Faatoai—Teea	1923	67	6	21	28	11	..	..	1	8.95	31.34	41.79	16.42	.....	.....	1.49
Faatoai—Taatuapæ	1923	500	17	288	123	70	..	..	*	3.40	57.60	24.60	14.00	.....	.....	0.40
Faatoai—Vaipapa	1924	444	95	163	127	25	..	..	34	21.39	36.71	28.60	5.63	.....	.....	7.66
Faatoai—Terahimaue	1923	391	37	145	172	21	*	6	10	9.46	37.08	43.99	5.37	.....	1.53	2.56
Faatoai—Mataitau	1923	266	40	110	88	3	..	18	7	15.04	41.35	33.08	1.13	.....	6.77	2.63
All	.....	6,778	804	2,626	2,535	1525	54	81	153	11.861	38.742	37.400	7.745	0.797	1.195	2.257

* Adolescent present.

The statistical description of the color classes is given in terms of the mean values of the characters for all of the local and annual series (tables 128, 129), as in the case of *striolata*. The figures are self-explanatory and do not call for detailed comment. As there is no consistent correlation between a particular color distinction and a structural average, it is evident that the two kinds of characters are independent in their genetic causation. In a given colony they combine according to the chances of mating, as conditioned by the relative prevalence of the components with their varying sizes, shapes and colors.

PARTULA TÆNIATA NUCLEOLA 'Pease' Garrett—EMBRYONIC MATERIAL

The statistics relating to fecundity (tables 130, 131) are in general agreement with those applying to other varieties of *tæniata*. About 75 per cent of the recorded adults were gravid and bore 2.3 items apiece, on the average. The reproductive rate for the whole series is indicated by the figure of 1.7 embryonic items.

Apparently there is no definite breeding season, for the figures vary greatly from place to place in a single year, and from year to year in the same locality, even during identical months. The first point is well illustrated by the contrasted figures of 48 per cent and 76 per cent of gravid individuals in Mataitau and Terahimaue respectively, when collections were made in the summer of 1923. The second point comes out clearly in the case of the Aareo series, when the gravid snails numbered 63 per cent, 77 per cent and 67 per cent, in 1909, 1919 and 1923 respectively.

The egg capsules agree with those of *simulans* in shape and size. The wall is invariably opaque and not at all like that of *striolata*.

The shells of the unborn snails are light brown or darker brown in the vast majority of instances (tables 132, 133). Very few display a banded pattern. Therefore the facts are much the same as in other varieties of *tæniata*, and their interpretation runs along similar lines. The real hereditary relations are not fully expressed by the data. As before, most of the young of **pallida** must be assigned to a **fusca** class although others are definitely **pallida** or **fulva**. A smaller proportion of the young produced by **fusca** depart in the lighter direction, while more are distinctly darker than their producers and are really **fulva**. The majority of the offspring of **fulva** parents are dark brown, while an even greater proportion of the young of **phæa-purpurea** are deep brown, even if none of them is an exact replica of its parent. It is evident that the parental classes tend to produce their like and also that they contribute some individuals to contrasted classes, although the increments in question are not always to be distinguished before birth. Hence free intercrossing obtains. At times the evidence of this is very clear, as in the case of a white embryo within the body of a **phæa-purpurea** adult.

The absence of **frenata** young and the presence of the small numbers of **zonata** and **lyra** young mean that the characteristic patterns of these classes normally develop only after birth. The fact that recognizable **lyra** embryos were found in **lyra** adults almost, but not quite, exclusively corroborates the points made in the preceding paragraph.

When the parent and offspring groups are compared as wholes (table 133), the amount of post-embryonic definition of the distinctive patterns is demonstrated. It is not at all probable that changes in color composition would come about in a single generation to the degree indicated by the figures if they were accepted at their face values.

PARTULA TÆNIATA SPADICEA Reeve—STRUCTURAL CHARACTERS

We now encounter the third member of the group to which *striolata* and *nucleola* belong, and the fifth primary variety of *tæniata* here described. It is the division given full specific status by Reeve under the name of *Partula spadicea*.

There is much confusion in the earlier literature regarding the identity of Reeve's species and as regards its habitat as well. The original specimen figured by Reeve was brought back by Cuming and attributed by him to the Marquesas Islands. Cox insisted that he had found *spadicea* in the Solomon Islands, probably confusing Reeve's type with an undoubted inhabitant of the Solomons, such as *Partula hastula*, as suggested by Smith. Pease regarded *spadicea* as a Solomon Island species, and Garrett states that he too was inclined to agree with Cox regarding the habitat of *spadicea*. Hartman affiliated *spadicea* with *tæniata* on its structural merits. Finally, Pilsbry treats *spadicea* as a primary variety or subspecies of *Partula tæniata*, and I follow his authority.

The original figure by Reeve pictures the most characteristic color variety of the group of associations herein held to be *spadicea*, and the structural characters of the illustration also agree substantially, except in the straightness of the columellar margin of the lip near the insertion. In the majority of the shells denoted *spadicea*, as in *nucleola* and *striolata*, this region is more or less nodulated. It is possible that future exploration of remote islands like the Solomons will bring to light a type which more clearly exemplifies Reeve's description, but as the facts now stand it is justifiable to treat the division of *tæniata* under consideration as Reeve's *spadicea*.

The associations united under this name on account of their colonial similarities dwell in the Rotui sector of Moorea, which constitutes the middle member of the northern geographical trident. Again we may stress the mutual agreements exhibited by the three series of relatively compact and incrassated *tæniata* which occupy the three areas in question. The Rotui region is devoid of *Partula suturalis*, but in its southwestern portion the related *Partula dendroica* is found; in Vaihiaiia Valley *spadicea* and *P. dendroica* exist in association. The southern valley of Tepatu lacks *spadicea* but it bears the offshoot variety of *Partula tæniata propinqua*. This southern hiatus and the dryer northern slopes of Mount Rotui divide the whole area of *spadicea* into western and eastern portions, whose *spadicea* inhabitants are somewhat different in the details of their make-up. A final areal point is that *spadicea* and its close ally, *propinqua*, constitute the most sharply isolated division of *tæniata;* the northern coast, the shores of Opunohu and Paopao Bays, and the low ground of Opunohu Valley to the south of Mount Rotui are clearly marked boundaries of this area. It is true that *Partula mirabilis* has crossed the relatively dry southern boundary so as to associate itself with *propinqua* in certain localities, and *elongata* has also entered the Rotui region in late years. But the area occupied by *spadicea* has no direct contacts such as exist in the cases of the territories held by *striolata* and *simulans*, *simulans* and *elongata*, and *simulans* and *nucleola*.

The characters of the *spadicea* associations are recorded in full in table 134, and they are further illustrated by the typical examples shown in plate 24, figures 26 to 47. In general form the shells are not so compact and abbreviated as those of *striolata* and *nucleola*, although the ranges of the several characters agree closely. The rounded aperture and heavier lip are the most important features

of resemblance to these varieties, while at the same time they mark the contrast with *simulans*. The shells vary greatly in all of their characters and particularly in the form and size of the aperture.

A single sinistral mutant was collected in southern Vaihiaiia in 1923 (plate 24, fig. 47). This presents a parallel to the reversed examples of *simulans* from Taapurau and the specimen of *elongata* from Oio Valley.

The weak development of the tooth is to be noted (table 135). In general the eastern colonies show a lower degree of expression of this feature than do those of the western subarea, although the Maahumeru association is really more like those to the west.

Colonial differences in structural respects are not more marked than in *striolata*, but they do appear despite the uniformity of the conditions throughout the compact Rotui sector. The eastern associations taken collectively are smaller and less compact than the combined western series, but their apertures exhibit different relations, being larger as well as slightly broader in proportions.

Annual or secular colonial changes are suggested by the figures for the two collections taken in Vaihere in 1909 and 1923, and by the figures for the Pupuhi-Teviroa series. Without doubt some variation occurs within the boundaries of one and the same valley, but this factor is excluded in the case of Vaihere, where the earlier and later series came from exactly the same restricted area of vegetation.

PARTULA TÆNIATA SPADICEA Reeve—COLOR CHARACTERS

All of the color classes of other varieties recur in *spadicea*, even though some of them do not correspond exactly in all details. The full census is given in table 21.

Light shells of the **pallida** class (plate 24, figs. 26, 27) agree perfectly with those of all preceding varieties, except *striolata*. While some darkening of the apex is shown in some representatives, this never becomes deep purple as in some examples of the class in *simulans*. The **fusca** shells (plate 24, figs. 28-30) are sometimes uniform in color (fig. 28), but usually they display transverse streaks of lesser or greater prominence (figs. 29, 30). The general effect produced by an aggregate of these shells is like that of **fusca** shells elsewhere, and hence it seems preferable to retain the same name rather than to establish a separate class under the title of **strigata**. Similarly streaked shells were found sporadically among other varieties which were so treated; the notable point here is that they constitute the majority of the class in most of the colonies.

Brown shells of deeper tint form the class **fulva** (plate 24, figs. 31-35) and these also are transversely marked with deeper brown in the greater number of instances. The original shell figured by Reeve belonged to this class. A variant having reddish-brown streaks (fig. 33) is rare. Very dark **fulva** shells (fig. 35) provide a transition to the next class, **phæa-purpurea** (plate 24, figs. 36, 37), which, therefore, is not so sharply demarcated in *spadicea* as in *nucleola* and *striolata*.

Double-striped shells of the class **frenata** (plate 24, figs. 38, 39) are rare in *spadicea*; indeed they occurred only in the colonies of middle Matapoopoo and

Punahara which are well separated geographically. The frenata of Punahara are somewhat allied to the lyra of that valley, inasmuch as the broad lower stripe of the former seems to represent the fused middle and lower bands of a lyra. The zonata class (plate 24, figs. 40-42) repeats the qualities displayed in other varieties. Ordinarily the bands are seal brown in color, but in rare instances (plate 24, fig. 42) the median, sutural and basal areas are deep purple-brown.

The last class, lyra (plate 24, figs. 43-46), is conventional, and its bands vary somewhat in location and in relative breadth, as in other varieties. The individual of figure 45 is a variant of lyra and not a frenata, because the stripes are entirely distinct on the whorls of the spire. The variant shown in figure 46, with wide sutural and basal bands, is a replica of the mutant of *nucleola* shown in plate 24, figure 25.

TABLE 21—*Partula tæniata spadicea. Census of the color classes*

Series	Year	No.	Number							Per cent						
			pallida	fusca	fulva	phæa-purpurea	frenata	zonata	lyra	pallida	fusca	fulva	phæa-purpurea	frenata	zonata	lyra
Western:																
Uhene	1923	425	140	148	77	..	..	21	39	32.94	34.82	18.12	.....	.....	4.94	9.17
Vaihere	1909	70	16	28	14	..	..	6	6	22.85	40.00	20.00	.....	.....	8.57	8.57
Vaihere	1923	128	32	53	19	..	..	6	18	25.00	41.41	14.84	.....	.....	4.69	14.06
Vaihiaiia north	1924	144	30	58	30	..	..	10	16	20.83	40.28	20.83	.....	.....	6.94	11.11
Vaihiaiia middle	1909	182	66	50	28	..	..	22	16	32.26	27.47	15.38	.....	.....	12.09	8.79
Vaihiaiia south	1923	287	75	D 102 / S 1	64	..	..	21	24	26.13	35.89	22.30	.....	.....	7.32	8.36
Matapoopoo middle	1919	619	189	141	81	50	6	95	57	30.53	22.78	13.08	8.08	0.97	15.35	9.21
Matapoopoo east	1923	1	....	.....	..	..	..	1	....	.....	.....	.....	.....	.....	(100)	.....
Eastern:																
Maahumeru	1919	38	9	23	3	..	..	1	2	23.68	60.53	7.89	.....	.....	2.63	5.26
Punahara	1923	512	94	223	159	..	12	..	24	18.36	43.55	31.05	.....	2.34	.....	4.69
Marure	1909	343	64	141	115	..	..	4	19	18.66	41.11	33.53	.....	.....	1.16	5.54
Pupuhi-Teviroa	1919	92	13	30	26	15	..	1	7	14.13	32.61	28.26	16.30	.....	1.09	7.61
Pupuhi-Teviroa	1923	275	29	87	98	46	..	1	14	10.54	31.64	35.64	16.73	.. ...	0.36	5.09
All	.....	3,116	757	1,085	714	111	18	189	242	24.294	34.820	22.914	3.562	0.577	6.065	7.766

While the proportions of the color classes differ from valley to valley, in general they are more uniform than in the series of *nucleola* or *simulans* associations. Among the more obvious matters of diversity we may note the sporadic occurrence of frenata and the local appearance of the darkest plain class, phæa-purpurea. In no case of colonial individuality is there an outward circumstance which might account for the fact, any more than the existence of the extraordinary sinistral mutant in Vaihiaiia could be so interpreted.

As the number of colonies is not very great, the quantitative characters of all of their color classes are recorded, in terms of the mean values with their probable errors (tables 136, 137). The value of the records will be more fully realized when similar studies may be made in the future. The data are self-sufficient and require no detailed elucidation. It is interesting to see how a given color class may stand away from its fellows in structural respects, like the zonata

of Uhene. In the next valley, Vaihere, it is lyra which departs from its associates. The chances of close-mating or cross-breeding on the part of the members of a color group may hold their offspring to a distinctive average, or may scatter them among various morphological sections.

PARTULA TÆNIATA SPADICEA Reeve—EMBRYONIC MATERIAL

The variety comprises fewer associations than any of the foregoing, but there are enough to provide data of value relating to fecundity and heredity (tables 138-141). Nearly 2600 gave records, and of these about 80 per cent were gravid—a figure that corresponds well with what the other varieties disclosed. The percentage of bearing adults varies considerably in one and the same year, from 64 per cent in Vaihere to 90 per cent in Punahara, during the calendar summer of 1923. A general breeding season does not seem to occur.

The average number of embryonic items carried by the fertile adults is 2.45, which again is closely concordant with other varieties. The embryonic rate for the whole series of recorded adults, namely, 1.94, also agrees substantially.

One very interesting quality of the embryonic capsule is to be stressed. In the eastern associations this is transparent, while in the western colonies it is fully impregnated. Among the former there are a few with slight clouding of the wall, but none is ever opaque. The contrast in question is particularly interesting in view of the clear nature of the capsule in *striolata* which exists in an adjacent but severed geographical section. It will be recalled that the eastern and northern associations of *simulans* are transitional in the quality under discussion. The absence of the impregnation in the eastern *spadicea* can not be referred to an environmental circumstance because the associated *Partula dendroica* of Pupuhi-Teviroa possess a densely opaque capsule. The correct conclusion is that genetic factors are responsible for the nature of the capsule in all cases, and that these factors vary like others within a single variety as they do from one species to another.

The single sinistral mutant from Vaihiaiia contained only one egg and no embryo. As in the cases of the other reversed mutants of *tæniata*, there is no answer to the question of the persistence of the changed condition.

The statistics relating to the color qualities of the embryonic shells (tables 140, 141) are much the same in nature and in meaning as in other varieties. The majority of the unborn young are plainly tinted with light brown, but some display definite color distinctions of other than the fusca class, precociously developed. Sometimes pallida, fusca and fulva young exist at the same time in the brood-pouch of an adult. All three types of banded young occur among the embryos, but it is clear that most of the adults so marked gain their characteristic patterns only after they emerge and that for the most part they are evenly colored as embryos. The figures of table 141 are significant in the same ways as in other varieties; *spadicea* offers no essential points of contrast with its associates within the species.

PARTULA TÆNIATA PROPINQUA New Variety—STRUCTURAL CHARACTERS

The last section of *Partula tæniata* includes a small number of associations which dwell in the southwestern and southern parts of the Rotui region. This subspecies is particularized by Pilsbry as "another race, tangent from *nucleola* . . . The dark-brown shell is profusely striped on the last 1½ whorls with cream white. The columellar denticle is small and prominent." Hence Pilsbry is the authority for its explicit recognition, although the name is my own.

While *propinqua* is indeed much like *nucleola* in its rounded aperture and stout character of the shell, it is really quite as distinct as *spadicea* and *striolata*. The geographical circumstances are very important. The variety came to light only in Vaihiaiia, part of Matapoopoo and Tepatu. In the last-named valley, *propinqua* is the dominant variety of *tæniata* to the complete exclusion of *spadicea*, as we have seen; lately *elongata* has invaded this valley from across the low ground to the south. In Matapoopoo a very mixed situation exists, inasmuch as *spadicea* and *elongata* also occupy certain parts of the whole valley, but without uniform intermingling everywhere. Finally in Vaihiaiia *propinqua* and *spadicea* dwell side by side with distinct and constant differences in structure and in coloration. As the *propinqua* of Tepatu exhibit more likenesses to the *spadicea* of the next area to the east, namely Pupuhi-Teviroa, it is probable that the present variety took its origin from *spadicea* in that general region, spreading later to Matapoopoo and to its present limiting area of Vaihiaiia. The name given to the variety indicates its geographical and morphological proximity to the older variety, *spadicea*. The alternative view that *propinqua* is an independent product of resolution from the ancient *primordia* stock, and therefore an equivalent rather than a derivative of *spadicea*, does not seem as probable as the opinions here adopted.

The total number of adults collected was 381; the adolescents and embryos amount to 32 and 211, respectively. Representative shells are shown in plate 24, figures 48 to 64. At first glance the noteworthy distinction is the color pattern specified by Pilsbry (plate 24, figs. 52, 53) but when the shells with such characters are closely examined their morphological characters gain the attention; the latter hold throughout the entire area of *propinqua*, while the color qualities differ greatly in the two extremes of the short range.

Among the prominent structural distinctions are, first, the columellar denticle noted by Pilsbry, which is generally emphasized but not invariably; this feature especially links *propinqua* with *spadicea*, *nucleola* and *striolata*. In the next place, the aperture is more rounded and the lip is more incrassated than in *spadicea*, and in both of these characters *propinqua* more nearly resembles *nucleola*. Finally, the spire is much more acute and prolonged than in *spadicea*, and the younger whorls are more rounded in profile. It is a simple task to assort the shells of *propinqua* and *spadicea* where they occur together, as in Vaihiaiia, on structural features alone, when the peculiar coloration of *propinqua* confirms the result.

The quantitative characters of the measurable shells are recorded in full in table 142. Considerable variation occurs in the absolute measures, but the proportions are much more consistent. The whole shell is relatively narrower than that of *spadicea*, in correlation with its greater prolongation apically. The aperture is smaller and narrower than in the nearer relative. Finally, the aperture is shorter in relation to the entire length of the shell, again in general correlation with the production of the spire. One might characterize *propinqua* by denoting it a combination of the *simulans* type in the general form of the shell with the *nucleola* kind of aperture.

The parietal tooth (table 143) is very weakly developed—more so than in any other variety of *tæniata* except only *elongata;* its variations in different colonies are considerable.

The few shells of the illustrations give some idea of the range of variation in shape and size, but they are only isolated examples which can not adequately represent the full series from which they are taken.

PARTULA TÆNIATA PROPINQUA New Variety—COLOR CHARACTERS

The groups into which *propinqua* falls on the basis of color and color pattern are six, and all of these may be brought into correspondence with the color divisions of other varieties, although in two at least the details are distinctive. The census of the whole variety is given in table 22, and the shells already noted (plate 24, figs. 48-64) exemplify their respective classes.

TABLE 22—*Partula tæniata propinqua. Census of the color classes*

Series	Year	No.	Number					Per cent				
			pallida	fusca	fulva	zonata	lyra	pallida	fusca	fulva	zonata	lyra
Tepatu	1919	65	12	22	23	1	7	18.46	33.85	35.38	1.53	10.77
Tepatu	1923	203	42	78	63	8	12	20.69	38.42	31.04	3.94	5.91
Matapoopoo	1909	16	..	..	14	..	2	.....	.....	87.50	.....	12.50
Matapoopoo	1919	28	6	4	10	..	8	21.43	14.28	35.71	.....	28.57
Vaihiaiia south	1923	3	..	..	3	..	..	.....	.....	100	.....	.....
Vaihiaiia middle	1909	58	..	..	55	..	3	.....	.....	94.83	.....	5.17
Vaihiaiia north	1924	8	..	..	7	..	1	.....	.....	87.50	.....	12.50
All	....	381	60	104	175	9	33	15.748	27.296	45.932	2.362	8.661

Light individuals of the pallida class (plate 24, figs. 48, 49) are typical, sometimes pure white and sometimes with a pale washed tint. Such shells are relatively abundant in Tepatu, but entirely lacking in Vaihiaiia. The fusca class (plate 24, figs. 50, 51) recalls its counterpart in *spadicea* by virtue of the transverse streaks which are strongly and almost universally developed; this class coincides with pallida in its distribution.

The fulva class (plate 24, figs. 52-56) is distinctive and unique within the whole species of *tæniata*. In the most characteristic members (plate 24, figs. 52, 53) the general ground-color is a deep chocolate or seal brown, with prominent

transverse streaks of cream color. This is the Vaihiaiia and Matapoopoo type. In Tepatu similar shells occur along with others having less-defined streaks (plate 24, fig. 54); still others exhibit so little in the way of transverse interruptions that they become practically uniform (plate 24, figs. 55, 56). The boldly marked shells recall those of *Partula suturalis strigosa*, as the interruptions of the color are similar in nature and the general effect is precisely the same.

It is noteworthy that the class **frenata** is never represented in *propinqua*, so far as the collections are indicative. It may exist in some undiscovered situation in sparse numbers.

The broadly banded **zonata** were found only in Tepatu; their counterparts in *spadicea* were more numerous. Usually the band has the same relative width as in other varieties, but occasional variants possess a still broader zone (plate 24, fig. 59) so as to duplicate the zonata *elongata* which served Mörch as his type of the whole species. The variant with a split zone (plate 24, fig. 60) is apparently a mutant; its like occurred also in other varieties.

The last class, **lyra**, is sometimes quite as typical as in other sections of the species (plate 24, figs. 61, 62). But a variant occurs where transverse interruptions break up the revolving bands to make a tesselated pattern which recalls again the peculiarities of some of the members of *Partula suturalis strigosa*. In this class, as in **fulva**, the general coloration enables the transverse creamy markings to appear with distinctness; the streaks are not so evident in the lighter **fusca** or **pallida**. None were exhibited by **zonata** shells.

The foregoing qualities of coloration, together with the structural characters and geographical limitations, amply justify the recognition of *propinqua* as a primary variety with full standing as such. It is best regarded as an offshoot from *spadicea*, and of relatively late origin.

Variation in the color make-up of the several colonies is self-evident from the returns. The two annual series of Tepatu agree closely. The Matapoopoo series are small and their patent differences are probably not significant. The Vaihiaiia colonies are mutually similar and they differ collectively from those of other valleys. So far as the facts are known, the environmental circumstances are the same for all three localities, as they are contiguous and their vegetation is practically continuous at higher levels. We have previously discussed this region at some length in the chapter on *Partula dendroica* whose range is almost coextensive with that of *propinqua*.

The statistical description of all the color classes is given in table 144. Within a single association, the subdivisions differ in the same way that various colonies differ. Each is an independent community, however, and the classes present similar contrasts in separate localities only as coincidence may occur. There is no evidence of correlation between restricted structural characters and a particular mode of coloration.

PARTULA TÆNIATA PROPINQUA New Variety—EMBRYONIC MATERIAL

Despite the curtailed range of this variety and its small numbers in most places, the embryonic material is sufficiently abundant to disclose many points of similarity to that of other varieties. The data are given in tables 145 and 146. About 76 per cent of 323 recorded adults were gravid. The average number of embryonic items is 2.55 for these, and the average number for the whole population is only a little less than 2. In the main the figures are self-explanatory.

In sharp contrast with its relative and neighbor in the form of *spadicea*, *propinqua* possesses a heavily impregnated and opaque capsule. In this respect it agrees with all its associates in the three valleys where it occurs.

The figures relating to the coincident occurrence of eggs and young are recorded in table 146. Again there is essential agreement with other varieties of the species.

Passing to heredity, we may note the regrettable circumstance that the single reversed mutant found in Vaihiaiia bore no embryos but only a solitary egg; obviously it had just begun to bear. We can not know whether its sinistrality would have reappeared in some or in all of its offspring, as we do know in the case of reversed mutants of *Partula mirabilis*.

The data recording the apparent heredity of the distinction in color (tables 147, 148) afford real evidence of the relationship of *propinqua* to the earlier described varieties of *tæniata*, although there are minor details of difference. The Matapoopoo figures are omitted, but the remainder are sufficient to give results. The prevalent colors of the embryonic young are medium brown and dark brown, with the latter more pronounced than in the preceding varieties. The result is that apparent fulva young are almost exactly the same in percentage among the embryos as among the adults. The excess of so-called fusca young means that many of them are destined to become pallida adults by the lightening of the color upon the larger whorls, while others are destined to resolve their earliest uniform brown tints into the banded patterns of zonata or lyra. Only a few precocious young of the striped kinds appear in the embryonic series.

SUMMARY AND CONCLUSION

The present chapter is in itself a virtually complete study of the problem of species. The material representing *Partula tæniata* is exceptionally abundant. It comprises colonies from all of the habitable areas of Moorea and it falls naturally into several distinct subdivisions having the rank of subspecies. Each of the primary varieties in its turn is composite, being made up of the varying colonies of more or less separated valleys. Finally the members of every association vary within the limits of their territory as do the colonies making up a variety, and as varieties with their diversities compose the entire species. The existing nature of *Partula tæniata* as a whole may be interpreted in terms of simpler antecedent conditions like those actually presented by other less-differentiated species, such as *Partula suturalis* and the forms preceding *suturalis* in the complete list.

The components of *Partula tæniata* are the six varieties of *elongata*, *simulans*, *striolata*, *nucleola*, *spadicea* and *propinqua*. With the exception of the last named, all were first described as independent species. While the mutual differences exhibited by these six sections are well marked, in my opinion as in Pilsbry's they are less in degree than what are conventionally regarded as specific distinctions.

The areal relations of the varieties (plate 15) are similar in principle to those of whole species, in so far as each of them occupies its own territory with some amount of overlapping. Something of the earlier history of the species in its entirety is disclosed when a comprehensive view is taken of the geographical situation. The variety *elongata* occupies a continuous area in the central part of the island, while *simulans* occurs in two separated regions on either side of the territory of *elongata*. It is evident that *simulans* must have spread uninterruptedly across the middle zone at an earlier period (plate 16) and that it has been displaced by *elongata* in that area. Incidentally these facts indicate that *elongata* is the younger of the two varieties. The other four varieties are confined to the geographical extensions of Moorea to the north, *striolata* to the northeast, *nucleola* to the northwest, *spadicea* and *propinqua* to the middle element of the Rotui sector. These four varieties are only a little less diversified than the two disconnected sections of *simulans*; their close community of origin is unquestioned. Hence they are components of a still more ancient kind of *tæniata*, pressed outward into the isolated projections of the island by a tide of *simulans* in the same way that the latter has been divided by a still later pressure exerted by the youngest variety, *elongata*. The common qualities of the four varieties designated as the oldest are exhibited also by species of Tahiti and Raiatea, notably *Partula filosa* of the first island; these qualities have persisted in the old varieties while they have altered to lesser and greater degrees in *simulans* and *elongata* respectively.

The variations exhibited by the several subspecies have been fully described in the species sections of this chapter; the intervarietal comparisons now require record (table 149) and comment. All of the measurable characters show considerable amplitude in their variations, and the primary varieties are not sharply distinguished in such respects. The mean values disclose the real collective differences. The variety *elongata* is narrow and relatively slender; *simulans* occupies an intermediate position, while *striolata*, *nucleola* and *spadicea* are collectively short and stout. The variety *propinqua* is somewhat anomalous. Individual examples of *simulans* may sometimes approach the general *elongata* type, while others may simulate *nucleola*; among the members of every variety some examples occur which resemble the average components of other varieties in some of their features. But the collective characteristics are distinctive, in the same manner that differences of greater degree serve to demarcate entire species. The summary figures for the whole number of measured shells (table 149) define the species for comparison with others.

Identical relations are exhibited by qualities that are not capable of quantitative determination. The texture of the shell is thinnest in *elongata*, inter-

mediate in *simulans* and heavier in the other varieties. The parietal tooth (table 150) is developed least in *elongata*, more in *simulans* and most fully in the compact varieties, with the exception of *propinqua*.

When the six varieties are compared comprehensively on the basis of their color make-up (table 23), they prove to be generally alike in the categories of the colors and patterns which they display, but some real differences are apparent. Each variety is characterized by a greater proportion of one class or another, and sometimes by the omission of some of the color components, notably *propinqua*. The variety *elongata* again stands at one end of a scale with a high proportion of **pallida**, a low percentage of **phæa-purpurea**, and the highest relative numbers of **zonata** and **frenata**. In a general way, *simulans* comes next. The four more compact varieties have larger numbers of **lyra** and of **phæa-purpurea** when they are taken collectively.

TABLE 23—*Partula tæniata. Comprehensive census of the color classes*

Variety	Total	Number								Per cent							
		pallida	fusca	fulva	phæa-purpurea	frenata	zonata	lyra	bisecta	pallida	fusca	fulva	phæa-purpurea	frenata	zonata	lyra	bisecta
elongata	6,164	2,506	1,442	962	15	505	704	29	1	40.65	23.39	15.61	0.24	8.19	11.42	0.47	0.02
simulans	9,417	2,640	2,988	2,361	361	785	201	81	..	28.03	31.73	25.07	3.83	8.34	2.13	0.86	.....
striolata	6,584	819	2,711	2,211	146	5	19	673	..	12.44	41.17	33.58	2.22	0.08	0.29	10.22	.....
nucleola	6,778	804	2,626	2,535	525	54	81	153	..	11.86	38.74	37.40	7.74	0.80	1.19	2.26	.....
spadicea	3,116	757	1,085	714	111	18	189	242	..	24.29	34.82	22.91	3.56	0.58	6.06	7.77	.....
propinqua	381	60	104	175	.....	.....	9	33	..	15.75	27.29	45.93	.....	.....	2.36	8.66	.....
Whole species	32,440	7,586	10,956	8,958	1,158	1,367	1,203	1,211	1	23.385	33.773	27.614	3.569	4.214	3.708	3.733	0.003

The conclusions derived from the comprehensive treatment of the measured characters, the qualities of texture and tooth, and the features of coloration are in line with the interpretations drawn from the analysis of geographical relations.

When the figures relating to fecundity are assembled (table 151), the several varieties prove to be remarkably uniform in practically all respects. The form *elongata* stands out from the others by virtue of the highest percentage of gravid individuals (86.69) and the highest average productivity—2.46 embryonic items for the gravid and 2.16 items for the whole recorded series. Possibly these facts account in part for the recent expansion of the territory occupied by *elongata* to the exclusion of *simulans* in the central area.

The assembled statistics for the apparent heredity of coloration (tables 152 and 153) bring out with great clearness the points that were made in each individual section. Very few fasciated individuals gain their distinctive patterns before birth; they are mostly uniform brown of some shade as embryos. However, enough of them are precociously distinguished to prove the general intercrossing of ornamented and plain classes. The absence of any **phæa-purpurea** young whatsoever is noteworthy, proving as it does that the deep color of this class is always a late acquisition. As the colors of the parent classes grade from **pallida** to **fulva**, the number of light-colored young decreases while the number of darker young increases regularly and progressively. The figures prove that the color distinctions may

justly be termed hereditary, and also that no barrier to free interbreeding separates the plainly colored classes of snails.

We may assume that the color composition of the whole species is essentially stable, at least so far as the succession of the single generation involved in the returns. Comparing the embryonic and adult color classes on the basis of their percentages in their respective populations (table 153) reveals differences indicating the extent to which post-embryonic determination of the definitive details of coloration comes about. A little less than 13 per cent of all embryos are **pallida** while 23 per cent of the adults belong to this class; obviously about 10 per cent of the brown embryos were destined to become lighter as they grew. Medium-brown embryos of **fusca** nature amount to 56 per cent, while less than 34 per cent of the adults are **fusca**; consequently 23 per cent of the former series would have become variously **pallida** by lightening of their color, **fulva** and perhaps **phæa-purpurea** by darkening, or fasciated types by the resolution of their early uniform tints into lighter and darker revolving zones. As we have noted, the number of distinctly striped or banded embryos is very small in comparison with the proportion of such kinds among the adults; the differences must be made up by increments from the unbanded groups of embryos.

The importance of the material of this species as summarized is exceeded by its value for the problem concerning the respective effects of congenital and environmental circumstances in determining the qualities of the snails. Wherever any other species occurs, with a wide or restricted range as the case may be, *Partula tæniata* is present also; but nowhere does a *tæniata* colony duplicate the distinctive features of such an associated species. Hence the "environment" can not be invoked to account for the specific qualities of the one or the other when they exist side by side. Two distinct varieties of *tæniata* may dwell in company in a single valley, such as *simulans* and *striolata* in parts of Vairare, *propinqua* and immigrant *elongata* in Tepatu, *propinqua* and *spadicea* in Vaihiaiia; here too it would be illogical to account for two sets of varietal qualities by reference to identical external conditions. Within one and the same valley, snails belonging to one variety but differing in form and in coloration occur at times on the same cluster of ferns, on a single leaf of caladium, or on the same whorls of a pandanus tree, where no possibility exists of diverse conditions other than those of congenital nature. The identical species or variety may be found in widely separated localities while different forms inhabit a single site. The case for congenital determination of the characters under consideration could not be more complete or sure.

CHAPTER XIII

GENERAL DISCUSSION

COMPARATIVE REVIEW OF THE SPECIES OF MOOREA

The main body of the present volume comprises a full analytical description of the ten species of *Partula* known to inhabit Moorea. In most cases the material is abundant and well serves for a detailed study of the characters of the snails and of the variations exhibited by these characters throughout their several areas of occupation. In the concluding sections of the special chapters the points of outstanding significance have been duly emphasized, whether these are matters of intraspecific nature, of interspecific relationship, or of evolutionary dynamics. It is now desirable to deal with these species comprehensively, for the sake of a general comparative treatment of the whole assembly existing in Moorea, and also to the end that significant features of more than one species may be given due recognition.

In the nature of the case, the present discussion is concerned primarily with the material dealt with in the present volume; but the general problems of relationship and distribution inevitably involve the whole complex of species existing in the Society Islands, such as those of Tahiti which have already been placed on record, as well as those inhabiting the Leeward Islands of the group—Raiatea, Tahaa, Huahine and Borabora. The last-mentioned forms have been sufficiently analyzed to make the results valuable for a surer estimate of the meaning of the Moorean species. But clearly the present discussion must be viewed as only a preliminary outline of what may be brought to completion when all of the species of the Society Islands have been described to the same full degree as those of Tahiti and Moorea.

The first task to be undertaken in the present section is the review of the ten species as so many taxonomic entities which collectively constitute an insular complex, with the fullest recognition of the basic value of the structural facts with which all morphological studies must begin. For the time, therefore, the phenomena of variation in intracolonial and intercolonial respects, as well as the facts of mutation and colonial change with the lapse of time, are deferred, although they are actually more vital for the problems of organic differentiation.

The entire *Partula* population of Moorea is divided into the ten groups denoted species on the basis of primary distinguishing characters of size, shape and color, together with minor qualities, such as the sculpture of the shell, form of the columella, swollen or flat nature of the whorls, and the presence or absence of a parietal denticle. Thus each so-called species, when taken as a whole, is marked as a primary genetic group by certain typical or average conditions displayed by a complex of characters which have come to be more or less distinctive through natural evolution from the qualities of the ultimately common ancestors of the genus

Throughout the present series of studies, the absolute dimensions and certain fundamental proportions of the shells have been determined biometrically, with the result that definite numerical characters have been determined for each individual

species. The characters of qualitative nature, such as coloration, are capable of statistical description in summary ways, and they are also important for specific distinctions; but clearly the quantitative data are most fundamental, and their value increases progressively as the species of other islands of the Society Group, and of other groups like the Mariana Islands, are similarly defined. Thus in time a complete and comprehensive biometric characterization of the entire genus will be constructed.

The essential statistical descriptions of all of the Moorean species are brought together in table 154, while text-figures 7 to 10 also present some of the summary characters in graphic form. The ten species are listed on the basis of the *average* values of the length of the shell, beginning with *Partula exigua* (15.23 mm.) and continuing to *Partula tohiveana* (21.73 mm.). The full table gives the figures for the absolute ranges of all characters, their mean values, the standard deviations, and the coefficients of variation as well. The species vary greatly in numerical representation, partly on account of marked differences in their areal occurrence and partly because one may be relatively abundant within its territory while another may be infrequent; but the probable errors of the more important determinations provide the means for an estimate of the real significance of the items of the biometric record.

Each of the sections of the tables has its own features of vital interest. In the case of the ranges, the outstanding fact is the overlapping or duplication of the curves of variation of the several species. Even the shortest shell of *Partula tohiveana*, whose shells have the highest average value when taken collectively, is as small in the matter of length as the longest among the individuals of *Partula exigua* which as a group displays the lowest average value in total length. So it is with the data relating to other characters of the shells. Hence a particular individual's condition in a single dimension or proportion can not be taken by itself for its assignment to a given species. All of the definable characters are required for the classification of the *Partula* into primary species.

The figures for the mean values of the characters of the several species accurately define the typical or average conditions which are the matters of focal interest in purely taxonomic connections. Their diversities indicate the degrees of evolutionary divergence that have come about in the course of their derivation from common ancestry. It happens very rarely that two species will be alike in a given feature, as are *Partula olympia* and *Partula suturalis* in the length of the shell; usually the differences are well marked and clearly significant when estimated in terms of their probable errors. Even in the case cited, the other characters diverge so widely as to render the coincidence in the one case of similarity all the more noteworthy.

The data are capable of treatment in another manner, which brings out the characters of a given species as a complex of distinctive features (table 155). In working out the biometric constants, the numerical variates were duly combined into classes, comprising 0.3 mm. of amplitude in the case of length of the shell, 0.2 mm. for the other direct measures, and single units of percentage in the case of

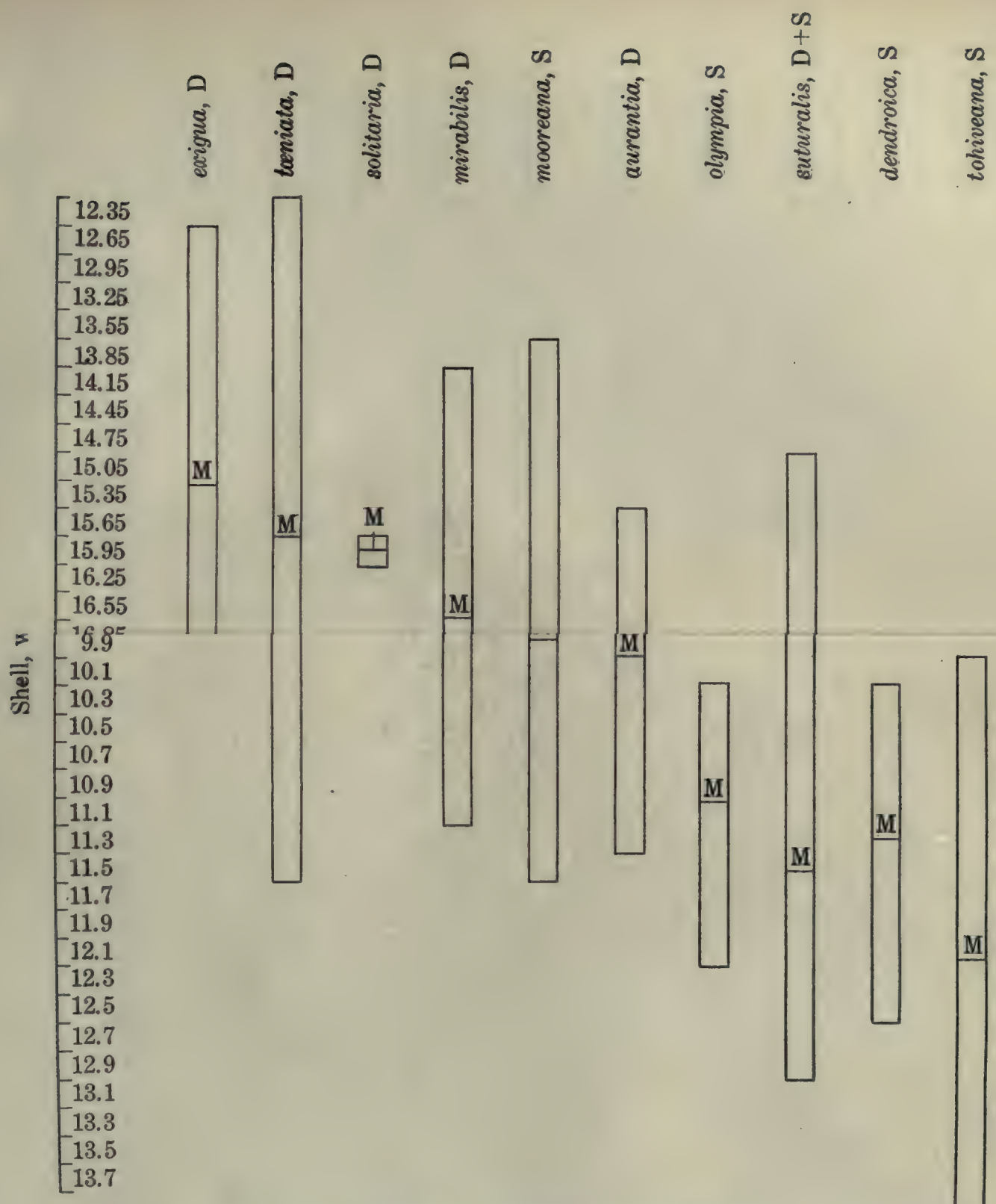


FIG. 7—Graphic representations of the characters of the ten species of Moorea.

FIG. 10—Graphic representation of the characters of the ten species of Moorea (concluded).

FIG. 10—Graphic representation of the characters of the ten species of Moorea (concluded).

the proportions. The mean value of any character naturally falls within one of these classes. For the sake of a comprehensive comparison, the mean values themselves were averaged, and thus a median class of the whole Moorean complex of species was determined for each character. Taking this as a o class, the average value of a character in a given species may be defined in terms of the number of classes by which it departs from the general or combined average. Employing the length of the shell as a concrete illustration, the average of all specific mean values falls in the biometric class with 17.75 mm. as its central figure; the condition of *Partula exigua* in this character is −8, because the mean of 15.23 mm. falls in the eighth class below the median group, while the condition of *Partula tohiveana* is +13 for analogous reasons. The full data of table 155 show how the species differ in their combinations of biometric characters as expressed in terms of their relations to a synthetic shell which would represent the general average of all species.

An important point may here be noted briefly, namely, the absence of any grounds for a belief in the principle of orthogenesis. The species differ in their individual ways and apparently with complete fortuity. For example, *Partula exigua* is −8 and −7 in the direct dimensions of the shells, and o in the proportion of the shell; the next species, *Partula tæniata*, is −7 in length, −4 in width and +2 in proportions. The larger species of *Partula dendroica* and *Partula tohiveana* differ much in the absolute dimensions but are the same in the proportions of the shell. No clear correlation exists among the descriptive figures to justify a belief in a directive or restrictive process which would confine the species within certain preordained limitations. The fortuitous nature of the interspecific differences of the Moorean species is quite as evident as the chance character of the variations exhibited by the members of one and the same colony of a single species, and by the colonial averages themselves in the case of a wide-spread species like *Partula suturalis* or *Partula tæniata*.

The data for the standard deviations are self-explanatory. The coefficients of variation are here recorded for the first time in the present volume; they show the absolute degrees of variability of the characters, irrespective of the nature of the concrete dimensions or proportions. A few of the noteworthy points may be emphasized. Species of small size like *Partula exigua* and *Partula tæniata* are really no less variable than types with large shells; indeed, the former are actually more variable in the proportions of the shells. Another general point is that the proportionate measures are less variable than the direct dimensions; this indicates that characters like length and width of the shell do not vary in complete independence but maintain a certain degree of correlation.

A final question in this connection is whether absolute variability is in any way correlated with numerical abundance or with the size of the area of occupation. To resolve this question the coefficients of correlation are given in table 156, where the species are rearrayed according to territorial extension and also according to their actual numerical abundance by virtue of the general agreement that exists between these two features. The single specimen of *Partula solitaria* is omitted. It appears that closely limited species like *Partula tohiveana* and *Partula*

olympia are somewhat less variable than species with wider distribution, such as *Partula suturalis* and *Partula tæniata*. Such a difference is almost inevitable in view of the opportunity for greater diversification than is provided by abundant and wide-spread colonies. But anomalies exist as notable exceptions. The sparsely represented species *Partula exigua* has a territory about equal to that of *Partula aurantia* or of *Partula dendroica*, yet it is clearly more variable than either of the two latter species. *Partula mirabilis* and *Partula mooreana* are represented by nearly equal numbers, and their wider territories are sensibly equivalent, but *Partula mirabilis* is distinctly the less variable in most respects. The ubiquitous species *Partula tæniata*, with the highest degree of varietal differentiation, falls below *Partula suturalis* in absolute variability. The conclusion is that each species possesses its own characteristic degree of variability just as it has its individual complex of distinctive characters as expressed in biometric terms.

Although the other characters which distinguish the several species of Moorea are not brought together in a summary way, a review of the circumstantial data discovers relations that are similar in principle to those disclosed by the biometric facts. The qualities of color and coloration are distinctive in any given species taken as a whole, but many of the forms of color exhibited by one species are repeated in one or in several of the other primary groups. Very rarely indeed is a particular banded pattern displayed by one species alone; the type named frenata appears in almost all cases where fasciation is shown at all, and the same statement holds for the zonata pattern as well. Nevertheless the species as collective wholes are distinguished by characteristic proportions of plain and ornamented shells; in further detail they differ in the proportions of the several subordinate kinds of individuals belonging to the latter category, as well as in the proportions of lighter and darker components of the unbanded subdivision.

Proceeding from the fact that the primary species of Moorea are distinguished from one another by a complex of quantitative and qualitative characters, each with its own range of variation within specific limits, the next subject for consideration is that of interspecific relationships. The ten species of the island are not separated by uniform degrees of difference but are unequally spaced, so to speak, within the range of the whole island complex. Those which are most distinct are *Partula tæniata*, *Partula exigua* and *Partula tohiveana*, as well as *Partula solitaria*, although the last named is very inadequately represented by a single specimen. The two species of *Partula olympia* and *Partula mooreana* constitute a couple with closer mutual affinities than obtain between either one of them and another species of Moorea or of another island; the same relationship is exhibited by *Partula aurantia* and *Partula mirabilis*, and by *Partula dendroica* and *Partula suturalis*. These facts mean that the members of any one of the couples specified have evolved from a common ancestral stock of ancient Moorea, and that their specific independence is relatively recent in origin. The number of fundamental stocks of prior times thus becomes seven, respectively to be denoted *pro-solitaria*, *pro-exigua*, *pro-tohiveana*, *pro-tæniata*, *pro-olympia-mooreana*, *pro-aurantia-mirabilis* and *pro-dendroica-suturalis*.

While it is theoretically possible that these seven stocks had themselves arisen from a single ancestry of still more ancient times, a different interpretation is supported by the likenesses between some at least of the Moorean stocks and species of other islands. My own views accord with those of Pilsbry, who has called attention to the resemblances between *Partula mooreana* and *Partula otaheitana*, *Partula suturalis* and *Partula nodosa*, *Partula tæniata* and *Partula filosa*—the first member of each pair being an inhabitant of Moorea while the second occurs in Tahiti. It is probable that *Partula exigua* of Moorea is a real ally of *Partula attenuata*, which exists both in Tahiti and in Raiatea. The chapter on *Partula tohiveana* gives the reasons for referring this species to an earlier ancestry common to a group of species now living in Raiatea, namely, *Partula formosa*, *Partula dentifera*, and the like.

These facts are very significant for an interpretation of remote episodes of differentiation among the species of *Partula* which long antedated the separation of such daughter species as *Partula olympia* and *Partula mooreana*, and the still more proximate processes by which the subspecies of *Partula tæniata* have attained their distinctions; these topics are to be discussed in the following section. However, it is really necessary to defer the consideration of interspecific relationships among the whole series of the species living in the Society Islands until the forms of the Leeward Islands of the group have been as fully analyzed and recorded as those of Tahiti and Moorea. A later section of this chapter, it is true, will deal briefly with these matters in connection with the question of subsidence of a larger land-mass of which the present islands are the as yet unsubmerged relics. The present summary discussion may well end with the conclusion that the ten species of Moorea are the derivatives of at least seven stocks of a former time, that four of these have not so differentiated as to originate anything else in the way of an independent product, while each of the others has given rise to two groups of descendants which are sufficiently different to be accorded the rank of species.

PROBLEM OF ORGANIC DIFFERENTIATION

We are now to consider the value of the present material for an interpretation of the procedure of evolution in nature, so far as a purely comparative study of species and of their varieties may discover anything in the way of evolutionary method. In the preceding section, attention was focused on the *typical* or *average* conditions of the several species, and these were discussed according to the conventions which hold for all taxonomic studies. The phenomena of internal diversification were by no means ignored, but they were made subordinate to the qualities of the species taken as wholes. We must now deal with the facts of the former category with several main purposes in mind: first, by arraying the species according to their degrees of internal diversification, to effect an interpretation of the more complex in terms of the less diversified; second, to discuss the various grades of complexity below the species; third, to consider the value of the material for the fundamental question of evolutionary dynamics; and, last, to evaluate the part that the process of natural selection plays in organic differentiation.

The detailed descriptions given in the special chapters have demonstrated that the species differ greatly in the matter of complexity. In the case of *Partula tohiveana* there is only a single compact colony whose members are defined in terms of the average values of their characters and of their variations about such typical conditions. A species which extends over a wider territory, such as *Partula mirabilis*, exhibits the same kind of variation within each of the component colonies, while in addition it displays the phenomenon of colonial variation throughout the entire range. The assembly of individuals constituting *Partula suturalis* is still more complicated, having all of the foregoing features, together with a clear segregation into two major sections whose average conditions differ more widely than do two colonial averages of either component. The most diversified species, *Partula tæniata*, comprises no less than six constituents possessing the status of primary varieties. But the array of genetically related groups need not stop at this point. Some of the species are mutually closer to one another than they are to the rest, notably *Partula suturalis* and *Partula dendroica*; such a couple forms a real natural group whose diversification is naturally greater than that of either member taken singly. The most inclusive assembly, with the extreme degree of internal complexity, is the whole series of species existing in Moorea. The foregoing are the terms of an array of genetic groups whose comparative treatment makes it possible to demonstrate something of the processes by which organic differentiation has taken place.

Proceeding in the inverse order, we must begin with the facts set forth in the concluding paragraphs of the previous section. Each of four species—*Partula solitaria*, *Partula exigua*, *Partula tohiveana* and *Partula tæniata*—is so distinctive in the averages of its several qualities as to warrant the conclusion that its own line of origin from an ultimate common ancestry had gained independence in very remote times. The relations between *Partula tæniata* of Moorea and *Partula filosa* of Tahiti, *Partula tohiveana* of Moorea and *Partula formosa* of Raiatea, prove that the period when the respective ancestral stocks began to segregate into the present well-demarcated species must have been so distant as to allow for the geological changes leading to the isolation of the existing islands of Tahiti, Moorea and Raiatea. Judging from what confronts us in the way of variation among the inhabitants of a single island today, the extensive land-mass as it existed before dissection must have supported several different stocks which had themselves come from the original generic beginnings of the whole natural group The particular variants which happened to dwell upon the higher centers survived to produce the generations which have changed more or less to become the island faunas of today.

As we have seen, the remaining species form couples whose members differ less than do the foregoing, when defined in terms of their typical conditions. Thus *Partula aurantia* and *Partula mirabilis*, for example, present a condition that must have obtained far earlier, when their common parent had emerged from a varying antecedent stock which has also given rise to some of the other species. The members of such a pair of species exhibit a greater degree of resemblance in collective qualities and a greater amount of overlapping of the curves of variation.

Hence we may judge that the common progenitor was itself an inhabitant of Moorea, and that the two species have been segregated since the island became isolated.

The next term in the series is the abundant group of individuals forming the single species *Partula tæniata*, whose condition of internal diversification is most instructive. This assembly comprises the substantial number of six components, termed "primary varieties," which differ among themselves by lesser degrees than those which distinguish *Partula aurantia* and *Partula mirabilis* or *Partula suturalis* and *Partula dendroica*. Indeed, all of the components which were known to earlier collectors were originally described as distinct species; whether their reference to one species is correct or not, the fact remains that groups here called varieties—*spadicea*, *elongata*, *simulans* and the rest—resemble one another more closely than do the members of the pairs specified above; hence they constitute a single genetic assembly, with a high degree of internal variation. The condition of *Partula tæniata* as a whole, therefore, presents what must have been an antecedent situation in the history of *Partula suturalis* and *Partula dendroica*, although six elements have been produced in the one case, while only two have come down to the present in the latter instance.

In its turn, the make-up of *Partula tæniata* is rendered intelligible as a product of an earlier and less-differentiated condition, like that now exhibited by *Partula suturalis*. The latter species comprises only two components, *Partula suturalis vexillum* and *Partula suturalis strigosa*, which differ far less than extreme variants of *Partula tæniata*, like the varieties *elongata* and *nucleola*. Despite the fact that the area occupied by *Partula suturalis vexillum* is greater than that inhabited by any one of the varieties of *Partula tæniata*, no distinct differentiation has as yet occurred to justify its subdivision into anything more than local colonies belonging to a single variety.

We now come to simpler species which, unlike the foregoing, have not been noticeably dissected into components with the varietal degree of discontinuity. Some of these occupy considerable territory, namely, *Partula aurantia*, *Partula mooreana*, *Partula mirabilis*, *Partula dendroica* and *Partula exigua*. The curves of variation of their several characters exhibit one general mode, and the variates group themselves about such averages in a manner approximating the normal. Thus each of these species is sensibly a counterpart of one of the primary varieties of *Partula suturalis* or of *Partula tæniata* Yet real differences exist among the colonial averages, proving that some degree of internal diversification has occurred; and although these have not yet attained the magnitude of a *varietal* difference, they are similar in kind. Hence, the general condition of one of these species presents a picture of what must have been a former stage in the history of *Partula suturalis* and of *Partula tæniata*.

At the end of the array stand the simplest species that comprise only a single compact association; these are *Partula tohiveana*, *Partula olympia* and *Partula solitaria*, although the last named contributes nothing to the discussion because it is represented by a single unique specimen. Each of the other specific groups is the

equivalent of a single one of the colonial elements which compose a more widespread species. As such, it displays what must have been an original condition in a species like *Partula aurantia* before this began to expand its territory so as to become a composite of several more or less isolated associations, as it is today. So far as the value for a comparative interpretation is concerned, it matters not at all that the observed condition of simplicity is secondary, in a sense. The whole analysis of *Partula tohiveana* reveals this species as the sole relic in Moorea of what must have been a stock so widely distributed as to have included the present island of Raiatea in its range. Without question the Moorean representatives of this stock were formerly extensively disseminated over Moorea, but they have all disappeared, save only in the small area of Fareaito Valley. The history of *Partula olympia* is analogous, but this species is more closely affiliated with *Partula mooreana* of the same island. The present single association of *Partula olympia* is therefore an outlying relic of a *pro-olympia-mooreana* stock with a wider range in former times than the two derivative species now possess; it has become isolated from its relative by the disappearance of the members of this stock which formerly existed in what is now the geographical gap between Mouaputa Valley and the territory centering about Vaianai Valley to which *Partula mooreana* must have been more closely confined, as the evidences show.

In summary, therefore, the several species of Moorea present various conditions of complexity, and these conditions constitute a series whose items are interpretable in terms of other members. A simple species with only one existing colony, such as *Partula tohiveana*, is the counterpart of a single colonial component of *Partula aurantia* or *Partula mooreana*. A species like either of the last named is similar to a primary varietal constituent of *Partula suturalis* or *Partula tæniata*. Finally, the degree of varietal differentiation exhibited by *Partula tæniata* needs only to be accentuated by further hereditary divergence to equal that which exists in the case of a pair of species such as *Partula aurantia* and *Partula mirabilis*. Still greater divergence, beginning in more remote times in the past, has resulted in more marked degrees of difference like those which distinguish other species of Moorea, such as *Partula exigua*, *Partula tohiveana* and *Partula tæniata* taken as a whole.

Throughout the foregoing discussion the conventions of taxonomy have been observed to the extent that the *Partula* fauna of Moorea has been considered as made up of genetic assemblages in the way of so-called species, distinguished by a certain degree of collective difference. It is apparent, however, that the accepted degree in question is quite incapable of definition, save in terms of relative amount, and it is therefore purely arbitrary. Comparative morphology, crystallized into taxonomy, must take some degree of difference as a criterion of specific status; and mainly for historical reasons, it begins with what is only one point of a continuous scale of differences. From this taxonomy works upward to genera and to more inclusive larger groups, and for the most part it is content to denote any distinguishable component of a species as a "variety." This term is very vague, and it has been employed in very different senses by taxonomists; sometimes it is

applied to larger components, sometimes to a small group of individuals, or even to single individuals which depart in any apparent respect from the type accepted as the norm. Logically, I believe, it should be reserved for those constituents into which a whole species may be resolved in the first analytical step, when, indeed, primary divisions of a species are to be recognized.

In dealing with the species of *Partula*, it has been found convenient to establish a scale of subspecific distinctions of various grades, down to the groups of individual variants which are substantially identical. These may best be explained by using *Partula suturalis* as an example. Lengthy as it is, the special chapter on this species fails to do justice to the manifold variations exhibited by its members in measurable dimensions, in their proportions, in color and pattern, as well as in sculpture and other minor qualities. Each presents its own particular combination of individual qualities that collectively set it apart from all others, although in any single feature it must naturally bear some resemblance to one or more of its associates. Some are striped spirally with two narrow brown bands which are alike in every determinable respect; for such a group the term *gens* is employed—a name indicating that the identical manifest qualities are the products of similar genetic factors. But when two stripes are present they are not always alike in their respective widths, in their relative intensities, or in the width of the intervening clear space. But however they may so differ in finer detail, they are at least alike in the possession of the two bands; and as genetic reasons must here be responsible also, the individual variants combined as gentes constitute an interrelated group of wider inclusiveness than the gens, termed the *cohort*. In the detailed description of *Partula suturalis*, as well as of other composite species, the cohorts distinguished on the basis of coloration are denoted the "color classes," and they have been given special names such as **frenata** for the two striped shells, **zonata** for the broadly banded individuals, and so on. Each of these cohorts is a "variety" in the sense that it is a component of a species, but it is too elementary to warrant the use of the conventional italics for its convenient specification, while furthermore the distinctions in question belong to only one of the categories of variation. A given shell may be a member of the same cohort or even of the same gens as another in the quality of ornamentation, while it belongs to a totally different subdivision in the category of size, of shape, or proportions of the aperture. The gentes and the cohorts of the latter characters are not so clearly defined as those of coloration, although they are actually capable of identical treatment in terms of the classes of variates, in ways that are exemplified in the comparative treatment of the species of Moorea in the first section of this chapter.

The combination of cohorts which exist in a single delimited valley is termed a *socius*. Each socius has its own individual constitution determined by the qualities of its constituent cohorts, which are themselves conditioned by the characters of their gentes and ultimate individual variates. Thus the socius found in Mouaputa Valley comprises the cohorts **strigata, frenata, zonata, bisecta** and **atra**, while the association in Haumi Valley includes **cingulata** and **pallida** as well. Further differences among the socii appear when the proportions of the color classes are taken into

account, as well as their presence or absence. Inasmuch as the socii differ in their collective qualities, they too are "varieties" of *Partula suturalis* in a true sense; their particular designation by the chosen term gives them a more precise position in the series of subordinate components of the species.

Assembling the whole series of socii that represent *Partula suturalis*, it is evident that they fall into two arrays, namely, the colonies from Paia to Atiraa Valleys, inclusive, and all of the other colonies of the island; the collective differences in question are greater in degree than those which distinguish any two socii of either of the subdivisions. The two series are the major distinguishable components of the whole assembly delimited as the species *Partula suturalis*, and according to the conventions of taxonomy they possess the status of primary *varieties*, duly named *Partula suturalis vexillum* and *Partula suturalis strigosa*. Beyond this point we would come to a genetic group of greater inclusiveness in the pair of related species, *Partula suturalis* as a whole and *Partula dendroica*.

The species employed as an illustration is exceeded by *Partula tæniata* in complexity, but the latter is subject to identical treatment. A species simpler than *Partula suturalis*, like *Partula mirabilis*, differs in the absence of differentiation into distinct primary varieties; hence its diversification is manifested only by the variations among the socii, which in turn are conditioned by their respective cohorts and gentes. The simplest species, *Partula tohiveana*, comprises only a solitary socius as well as only a single variety; here the characters of the cohorts and gentes are the sole determinants of the species in its entirety.

The particular terms that have been employed for these groupings are less important than the conceptions growing out of the analysis. The essential point is that the components of a species are genetic groups of various grades. The most elementary is the gens, composed of individuals which are exactly alike in at least one distinguishable character; the cohort, socius and variety follow in an ascending order of comprehensiveness and internal diversification. This scale of intraspecific groupings is directly continuous with the array of cospecific assemblies with which the prior discussion was concerned. Again we come to realize that the degree of difference taken as the criterion of specific status is purely arbitrary and that it makes only one point in a scale that grades from differences among gentes at the lowest limit to generic and greater contrasts in the upper range.

The material of *Partula* constitutes an ideal concrete illustration of the concepts outlined by Darwin in the classic paragraphs of the second chapter of the *Origin of Species*:

> "Certainly no clear line of demarcation has as yet been drawn between species and subspecies—that is, the forms which in the opinion of some naturalists come very near to, but do not quite arrive at, the rank of species: or, again, between subspecies and well-marked varieties, or between lesser varieties and individual differences. These differences blend into each other by an insensible series; and a series that impresses the mind with the idea of an actual passage.
>
> "Hence I look at individual differences, though of small interest to the systematist, as of the highest importance for us, as being the first steps towards such slight varieties as are barely thought worth recording in works on natural history. And I look at varieties which

are in any degree more distinct and permanent, as steps towards more strongly marked and permanent varieties; and at the latter as leading to subspecies, and then to species. A well-marked variety may therefore be called an incipient species."

The foregoing considerations lead us directly to the problems of evolutionary dynamics. Since the time of Darwin these have come to be investigated with increasing attention to intraspecific diversities and less with reference to such degrees of difference as distinguish species. The latter are clearly the later products of a process of divergence that first brings about the differentiation of varieties. In turn the distinctions between varieties are conditioned by the contrasts of socii, of cohorts, and ultimately of the most elementary genetic groups in the way of gentes. Consequently *the origination of individual differences* is the elementary episode of any and of all evolutionary diversification, and the causes that induce such elementary episodes need only to continue their work without the aid of any other factors to bring about increasing degrees of difference. By virtue of the nature and behavior of the genetic machinery, the offspring of the members of a single parent gens come to differ, with the result that a cohort comes into being; cohorts vary because the individual variants of their component gentes have come to be genetically unlike—and so on, to the greater contrasts of socii, varieties, species and genera.

Thus we arrive at the conclusion that the methods of the geneticists are required for an elucidation of the fundamental dynamics of organic differentiation, and that a fuller understanding of the natural history of the species of *Partula* would be gained by supplementing what we have termed the analytical taxonomy of the material by actual experiments on heredity in the laboratory. As yet, however, the time and labor required for investigations of the kind described in this and in previous volumes have precluded the possibility of such experimentation. Nevertheless, the viviparous habits of the snails have made it possible to obtain much information regarding the inheritance of coil and color, as recorded in the special chapters. So far as this goes, it fully accords with the results of laboratory genetics. The elementary episodes of organic differentiation in nature that have been demonstrated, and the long history of evolution that they elucidate in part, reveal no originative factors at work other than those of internal, congenital nature. To what extent external influences may control or alter the manifest effects of the internal factors is difficult to determine with finality, but in my opinion they are not able to originate new qualities as such. A later section will deal briefly with this topic on its own merits.

In conclusion a few words may be devoted to the subject of "natural selection," with the prefatory statement that I believe fully in the reality of the processes included under this term. Darwin clearly separated this from congenital variation, taking the latter on its factual merits, without that fuller understanding of the factors which later research discovered in the material chromosomal machinery. Some among the neo-Darwinians endeavored to make natural selection originative as well as discriminatory, but their views have not gained wide acceptance. Given the self-evident phenomena of universal congenital variation, other natural proc-

esses follow inevitably in the way of over-production, struggle for existence, and the elimination of the unadapted, thus leaving only those individuals to carry on which are congenitally fitted to meet the exigencies of their lives. The crucial point is the survival value of small differences, such as the individual diversities whose origin is herein stressed as the elementary episode of all organic differentiation. Darwin himself did not insist on the positive and universal utility of these small individual differences, for he clearly recognized the category of "indifferent characters"; others upheld the extreme view that whether or not these minor differences can be demonstrated to be adaptive, they must be so or else their possessor would not survive. This begs the whole question.

What is clearly evident is that an individual departure of congenital origin *must not be inutile*, that is of such a nature as to lead to the elimination of the organism or to exclude it from participation in the genetic exercises of its association. The rare reversed mutants of the right-handed species *Partula tæniata* are fully viable, but their congenital departure might render them unable to mate with dextral snails and to perpetuate their changed condition. On the whole, however, the mutant characters actually demonstrated in the categories of size and shape and color do not appear to be critical, either as directly favorable or as immediately unadaptive. They appear, persist, or disappear according to the workings of the congenital mechanism. Apparently the only question relating to their adaptive or other nature concerns their correlations; if a mutation in a single dimension is out of balance with another quality, a snail might come to be in a state of insecure equilibrium, and thus be eliminated. "Congenital variation must not be eliminative" is the correct statement of the categorical imperative of organic differentiation, and I do not regard it as contradictory to the contentions of Darwin in any essential respect.

EVIDENCES OF CONTEMPORANEOUS ORGANIC DIFFERENTIATION

Owing to the methods employed in the present investigation, and as the result of the detailed analysis of the material, definite information has been obtained showing how the elementary episodes of organic differentiation take place and how larger differences of various degrees may be interpreted as the product of their accumulation. We may now review the pertinent facts in a general way, although a comprehensive summary can not do full justice to the circumstantial data recorded in the special chapters.

The most direct and therefore the most important evidence is provided by actual instances of mutation in various characters, appearing in several of the species. Next in significance are the colonial and varietal changes that have occurred during the years of personal study, namely, from 1907 to 1924. Certain species and varieties as observed in 1907 proved to be different in some respects from what Garrett had described for an earlier period, and the phenomena of recent diversification thus disclosed constitute a third body of fact. At the last come the still more remote historical changes which are deduced from the available information in the way of the foregoing more or less direct evidences, as well as from the com-

parative analysis of the whole series of Moorean and other species. Only the changes included under the first and second headings may justly be called contemporaneous, it is true; but even those of the third category are comparatively recent, and they very nearly deserve the same characterization.

Perfect and unassailable cases of mutation are those where embryonic offspring are borne in the brood-pouch of a parent from which they differ in the mode of coil. The dextral spiral prevails in the vast majority of individuals belonging to the new-found species *Partula mirabilis;* an adult of this kind containing a reversed embryo was found in Maramu Valley, where no other sinistral representatives of the same species came to light. No less than three identical cases appeared in the collections of *Partula mirabilis* from Faataofe Valley. A gravid individual of the sinistral species *Partula mooreana* from Tefeo Valley bore two young of the contrasted dextral coil. All of the full-grown and adolescent examples of *Partula suturalis vexillum* taken in Maraarii Valley were sinistral, but one of the former contained an embryo with a directly coiled shell. No evidence of independent and spontaneous production of offspring which differ clearly from their parents could be more conclusive.

Other cases are recorded in the special chapters which supplement the foregoing. The material of *Partula tæniata* comprises more than 57,000 snails of all ages, and among these are four adults of reversed nature. Two were found in Taapurau Valley as members of the variety *simulans*, one was an example of the variety *elongata* taken in Oio Valley, and one was a *spadicea* from Vaihiaiia Valley. The areas in question are far removed from one another and the novel individuals are unquestionably the results of independent mutations in body form. In each of the colonies of the dextral *Partula aurantia* located in Paparoa Valley and in southern Paraoro Valley, a single sinistral adult was found; their independence in origin is assured by the discovery of the first in 1909 and the second in 1923, and hence it is certain that they are not the offspring of parents belonging to a very sparse sinistral component of the species. Two partly grown dextral examples of *Partula mooreana* were taken in 1919 in Oio Valley, while the distant localities of Maramu and Faataofe Valleys yielded respectively three and four adults of the unusual form. Returning to the dextral *Partula mirabilis*, the colonies of Faataofe and Maramu both contained reversed shells whose origin by mutation is supported by the conclusive cases cited in the preceding paragraph.

The question immediately arises whether the sporadic individuals which differ from the majority in the matter of coil actually perpetuate their changed conditions. While some do not, others do transmit the new quality. One of the dextral mutants of *Partula mooreana* in Maramu Valley bore a dextral offspring like itself, while another produced an embryo which reverted to the standard coil. Three of the four similar mutant adults of *Partula mooreana* from Faataofe Valley carried sinistral young, while the remaining identical adult *contained one dextral young and one sinistral young at the same time.* The last case is duplicated by the reversed examples of *Partula mirabilis* from Faataofe Valley which also produced both kinds of young at once, and by the extraordinary instances of *Partula suturalis* in the Faamaariri division of Vaiare Valley.

In the nature of the case, mutations in size and form can not be discovered in embryonic material, but several instances have been found among adults which belong to these categories. A giant individual of *Partula suturalis* appeared in Oio Valley and another in far-distant Urufara Valley; the latter is the longest example of its species in the collections. Another abnormally large snail taken in Oio Valley was a member of *Partula mooreana*. Dwarfed individuals with all of the marks of adult nature were also discovered. The example of *Partula tohiveana* from Fareaito Valley is remarkable for the reason that it simulates an ordinary individual of *Partula mooreana*. The diminutive type of *Partula mooreana* found in Vaianai Valley is interesting as a local mutant, especially because the members of the same species in the neighboring valley of Atimaha are collectively much smaller than the associations of the same species elsewhere; the general condition in Atimaha Valley may reasonably be regarded as the result of abundant and repeated changes in the direction of reduced stature in the way of mutations.

Like the foregoing, instances of mutation in the qualities of color are practically unrecognizable as such among embryonic snails, because a contrasted offspring may be the result of a mating on the part of the parent with a member of a different color class. However, there is some evidence in the distribution of certain components which indicates that changes in this category also may arise spontaneously. Two color types of *Partula mooreana*, namely **cingulata** and **bisecta**, were found in Vaianai Valley—one of which also occurred in Atimaha Valley—that are exceptionally local. They are not mentioned by Garrett who collected thousands of specimens of this species in Vaianai Valley, and hence it is more than probable that they are recent in origin. The **brunea** type of *Partula exigua* is very sparse in Paraoro and in Faamaariri-Vaiare, and again it would seem that the kind is new.

When the collections of the later years of field-study are compared with those secured from the same valleys during the earlier years, distinct differences often appear which are interpretable in terms of accumulated episodes like those cited above. The statistical comparisons of the Vaianai colonies of *Partula suturalis vexillum* are especially instructive in this connection, as are also the colonies of *Partula suturalis strigosa*. Changes in the relative proportions of the color classes are revealed in many cases. In the category of spirality, what is perhaps the clearest instance is that of *Partula suturalis vexillum* in Uufau Valley, described in full detail in the special chapter, because here it is completely demonstrated that the proportions of the sinistral and dextral components of the colony have altered definitely in the direction of a more general dextral constitution.

When my own material is broadly compared with the collections made by Garrett from 1860 onward, marked differences are seen in many ways, showing that changes had taken place in some species at least since Garrett made his observations and prior to 1907. These are both areal and constitutional. The former are interesting because a species which enlarges its territory so as to establish itself in several more or less isolated localities gains more opportunities for independent colonial differentiation. The case of *Partula mooreana* is very clear, for it is certain that this species has only recently migrated to the present limits of its range

in Tefeo and Roroie Valleys, across the divide, and to Haapiti Valley to the northwest, from the original headquarters in Vaianai Valley. The variety *Partula tæniata elongata* has also reached new-won territory in very recent years. The whole history of *Partula suturalis vexillum* is by far the most important because in this case the evidence is most conclusive that the variety has reached the valleys of the extreme northwest and northeast since Garrett's time, while in addition the intrinsic evidence of the material itself proves that a prior general condition of sinistrality is steadily giving place to one of prevailing dextral nature. The histories of *Partula mirabilis* and *Partula aurantia* are also important in the present connection, mainly, however, as supplementary instances of recent enlargement of the territories of occupation.

All of the recent and contemporaneous changes like those here summarized materially assist in interpreting the still more remote processes of differentiation by which the varieties of *Partula tæniata* and *Partula suturalis* have come to differ, and by which also the now-separated species have gained their independence, in ways that have been discussed in the earlier sections of this chapter.

PROBLEM OF A FACTORIAL ENVIRONMENT

A just estimate of the relative values of congenital and environmental factors of organic constitution is still one of the principal aims of biology today, as it has been for many centuries. The whole problem involves two matters, first, the question as to how much of an individual's make-up may be due to the incidence of external influences, and, second, the question as to the transfer to offspring of environmental effects if such, indeed, are actually induced. The brilliant investigations of recent decades in experimental genetics, cytology and embryology warrant the broad general statement that congenital factors are paramount, that they are solely responsible for qualities as such, and that if external influences exert any effects whatever their rôle is limited to quantitative modifications of the expression of innate qualities, which modifications fail to reappear in offspring.

The present study deals with species and varieties in a state of nature and with the differences displayed by the snails down to the unitary items of individual diversity. Its category, therefore, is sharply contrasted with that of experimental studies in the laboratory and garden, although the two have the common element of an interest in the initial episodes of organic differentiation. The results of my own studies accord fully with those of experimental genetics, as I understand them to be capable of formulation in the above-stated terms. Almost every chapter includes some discussion of the problem of environment, so it remains only to survey the material in a general way, with some regard to the whole distribution of the species of *Partula* throughout Oceania, and with more special consideration of the forms dwelling in Moorea.

Each archipelago of Oceania in which "high" islands of volcanic nature occur possesses endemic species that are distinguished by lesser or greater degrees of individuality in their several characters. Few would contend today, I believe, that environmental conditions peculiar to the group are responsible for the occur-

rence of *Partula gibba*, *Partula radiolata*, *Partula fragilis* and *Partula salifana* in the Mariana Islands only, and that the complex of species existing in the Society Islands differs because the diverse organic qualities of the snails have been evoked by surrounding circumstances which are not the same in the Society Islands as in the Mariana Islands. The biological nature of the organisms and their relations to the various ecological conditions of their settings leave no doubt that congenital factors only are responsible for the contrasts displayed by the two groups of endemic species specified.

Moorea possesses its own indigenous forms which do not exist in Tahiti or in another island of the Society Group. Only an appeal to ignorance could be made in an endeavor to account for the distinctions of the Moorean species by reference to external causation, for all efforts are futile to discover an inorganic or heterogeneric biological difference between Moorea and Tahiti. Through their proximity and similar geological origin, Tahiti and Moorea are virtually as much alike as are the two subdivisions of the former island.

Narrowing the further discussion to the forms of Moorea, the first point is that the same general principle of geographical distribution holds for the insular complex as for the island groups in their relation to the array of the whole archipelago; in general terms, the formula is that an essential correlation exists between the degree of likeness on the part of the organisms and the degree of geographical proximity or isolation of their habitats. The species *Partula olympia* is more nearly related to *Partula mooreana* of the same island than it is to any species of another island. The similarity in question is fully accounted for by the origin of the two species from a common ancestral stock, and the distinctions must be viewed as the products of divergent congenital differentiation. There is no need for an appeal to unknown insular circumstances of identical nature which might have called into being the qualities of likeness and which are sufficiently different in detail in Mouaputa Valley and in the Vaianai region to bring about such distinctions as are displayed by the two species. The same argument holds for the other pairs of related species which inhabit separate regions of Moorea, namely *Partula suturalis* and *Partula dendroica*, *Partula aurantia* and *Partula mirabilis*.

Considering next those species which dwell in sharply restricted territories, we find it impossible to discover environmental factors which would account for the appearance of *Partula solitaria* only in a subsidiary division of Faatoai Valley, of *Partula tohiveana* in Fareaito Valley alone, and of *Partula olympia* in Mouaputa Valley and nowhere else, especially when *Partula tæniata* exists in association with all of these forms as one and the same species. Obviously it would be inconsistent to attribute the like qualities of the members of *Partula tæniata* to supposedly similar circumstances throughout the island and at the same time to refer the distinctions of the other species to diverse external conditions. Other species inhabit wider areas than the three specified above, but in no case can the likenesses displayed by the colonial components of any one of them be referred to elements of the environment peculiar to a particular sector or area. The species *Partula aurantia*, *Partula mirabilis* and *Partula mooreana* are especially significant because

trustworthy evidence shows that each of these species has expanded its territory in recent years without any departure from its specific distinctions in the new-won areas. *Partula suturalis* contributes many items of additional proof, presenting as it does two differentiated varieties which occupy separate but contiguous regions with exactly similar ecological conditions. Further, the variety *Partula suturalis vexillum* has recently spread from its earlier limited headquarters to the extremes of the main crescent of mountains, and it has changed from the direct to the reversed mode of coil in both directions. There are no grounds for supposing that the valleys of Uufau and Vaiare are alike in such ways as to make the snails dextral and sinistral in the same associations, or that the surroundings encountered by the most advanced migrants in Maharepa and Faatoai Valleys have imposed the reversed mode of coil upon the recent arrivals.

In one or in another of its varietal forms, *Partula tæniata* occurs everywhere throughout the island with various associates in different sectors and valleys. But there is no parallelism in any case between the distinguishing characters of a variety of *Partula tæniata* and the organic differentia of an accompanying species. The variety *nucleola* in the northwest is small and stout, while the representatives of *Partula suturalis* in this region are long and slender. The variety *Partula tæniata simulans* occurs side by side with reversed *Partula suturalis vexillum* in the western valleys of the outer circle and with dextral *Partula suturalis strigosa* in the Haumi-Afareaito tier of valleys. Two varieties exist in the Rotui sector as *Partula tæniata spadicea* and *Partula tæniata propinqua*, together with *Partula dendroica*, where it is manifestly impossible for identical surroundings to have produced unlike organic effects. Time and again a single nurse-plant was found to harbor snails of three or four distinct species which differed in further detail in the characters of color and coil, which are demonstrated by the embryonic material to be hereditary without any environmental intervention. In brief, no discernible differences in external circumstances can be found to account for the occurrence of diverse combinations of species and varieties in the several habitable areas of Moorea, whether these are topographical sectors like the Rotui region, individual valleys, or subsidiary divisions of a single valley.

The further we carry the analysis of the individual colonies of the several species, the clearer it becomes that a factorial environment is excluded. Added to all of the foregoing citations we have at our disposal the abundant and universal facts of variation on the part of the characters of the snails in quantitative and qualitative respects, where the surroundings must be identical in any single association. The direction of the coil, size, shape and coloration vary in ways that are completely explicable in terms of congenital causation; again we may cite the great value of the embryonic material in this connection. Other specific instances are noteworthy. The mutant dwarf of *Partula tohiveana* and the mutant giants of *Partula mooreana* in Oio and of *Partula suturalis* in Urufara Valley can not be attributed to the incidence of peculiar external influences which have affected them alone and not other members of their communities. The excessively rare sinistral mutants of *Partula tæniata* were found in three separate localities which have

no common peculiarity in ecological respects. Different color types are present in the brood-pouch of a single parent where all of the conditions other than those of innate nature must necessarily be the same. Finally, the instances cited where sinistral and dextral young appear in company apparently provide the most convincing proof that could be desired.

The evidences are cumulative, without any discrepancy, that so far as the present material is concerned the factors responsible for specific, varietal and lesser distinctions are congenital in nature and location, and that environmental circumstances produce no discernible effects upon the course of organic differentiation.

PROBLEM OF SUBSIDENCE

The genus *Partula* with its numerous and widely scattered species provides material that realizes the ideal for the study of the phenomena of geographical distribution. And incidental to this study is the much-debated question as to the former existence of an extensive mass of land in part of the Pacific Ocean, which has subsided to such an extent as to leave only the peaks of the highest mountain ranges still above the surface of the sea. A subsidiary part of this whole problem is concerned with the history of coral atolls, but for our purposes this is negligible because no species of *Partula* are known with certainty to occur on islands of this nature, despite the erroneous references in the literature to the contrary. It is true that some species exist on uplifted limestone masses which were formed as coral reefs reaching formerly to sea-level only, and the history of such species constitutes a special problem to be considered on its own merits. In the main, however, we are concerned with the forms dwelling in the "high" islands which are volcanic in nature as well as relatively lofty.

Moorea is a single element of the Society Group which is itself only one of about eighteen circumscribed archipelagos where species of the genus are known to occur. Hence the forms discussed in the present volume constitute a very small part of the whole array available for the discussion. To appreciate their significance it is necessary to take into account the species of other islands of the Society Group in the first instance, and then to extend the survey to include the forms of other groups of islands that lie near to or far from the areas serving as starting points. A whole volume would be required for the discussion of the entire area and the complete series of species of the genus, and as the species of other islands and groups come to be recorded as are those of Tahiti, Moorea and the Mariana Islands, such a volume will take its form. At the present juncture the whole problem may be outlined in brief form, with an immediate interest in the phenomena of distribution of the species and varieties of Moorea described in detail in the special chapters.

Broadly surveyed, an outline circumscribing that part of Oceania which includes the islands inhabited by *Partula* has the general form of an oval or ellipse with an oblique long axis, approximately 4500 miles in length, extending from the Austral Islands at the extreme southeast to the Mariana Islands at the northwest. The larger islands within this extensive area are mainly volcanic, some being relatively young as their regular conformation attest, while others are older and

much eroded like Tahiti and Moorea. These are the fundamental geographical data for the problem.

Each habitable group of islands possesses its own endemic species, with a single notable departure from the rule in the case of *Partula hyalina*, which occurs in the Society, Cook and Austral Groups—very near to one another geographically. Furthermore, each habitable island of a group bears species that do not occur in another island, although there are more exceptions to this general statement than to the former. Finally, each species of a single island has its own area of occupation, sometimes very contracted, like that of *Partula tohiveana*, sometimes coextensive with the forested areas of the entire island, as in the cases of *Partula tæniata* of Moorea and of *Partula otaheitana* of Tahiti. All of the species in question possess the common qualities which assign them to a single genus and which provide the proof that they are derived from a single ancestral stock of some far-distant time. Such are the basic biological considerations which require explanation. Needless to state, geographical distribution of other groups of organisms must be taken into full account, whether these are land-gasteropods or other animals.

The geologists are divided in their opinions regarding the origin of the islands of the Pacific Ocean. According to one extreme view, all of the present islands have been produced independently by local vulcanism. Middle ground is taken by those who recognize the older nature of certain rocks in such islands as the larger members of the Fiji Group and in New Zealand, and who would agree that these islands are the unsubmerged relics of a prior land-mass of considerable extent, while they would contend that the islands further to the eastward are sporadic and independent products. The final theory is the contrasted opposite of the first, namely, that an earlier land-mass extended all the way to the extreme borders of Oceania, that subsidence has led to the segregation of one coulisse after another, and that these separated ranges subsided later to greater degrees. Some of the peaks have remained above the surface as the present "high" islands, while others were more completely submerged to serve as the bases for the growth of corals and corallines. Isostatic readjustments would account for the extrusion of lava to cover the original layers of rock, while local compensatory folds would lift up old coral masses to become members of the third category of islands.

Like the geologists, the botanists who are concerned with the distribution of plant forms hold various views regarding the geological history of the islands of Oceania. But the zoologists who have investigated the land-gasteropods are virtually unanimous in their adherence to the explanation involving subsidence. They picture a large extent of dry land separated off from Asia, in which the original members of the genus *Partula* gained their distinctions, and throughout which the animals came to vary in different ways in different subordinate areas. As each major archipelago became disconnected, some of its forms evolved along lines mainly peculiar to the group, while others held with greater conservatism to the original qualities of their parentage. The same processes of dissection of the land, isolation of members of the insular complex, and independent evolution of the segregated associations continued to bring about the present distribution of

the species of the genus whose outstanding characteristic is the highest degree of endemicity anywhere to be found.

The only alternative theory which can be formulated involves human transport of species from one group to another and from one island to another within the group, with some degree of subsequent evolutionary change. It is freely admitted that terrestrial gasteropods of small size, able to dwell near the shores of Polynesian islands where the natives establish their villages, have been more or less widely disseminated by human beings since their advent into Oceania. It is possible that similar agencies have brought *Partula hyalina* to the Cook Islands and to Tahiti from its headquarters in the Austral Group. The available evidences make it practically certain that *Partula gibba* has become an inhabitant of Saipan and Tinian in the Mariana Islands by human carriage from Guam. But when due allowance is made for cases such as these, there remains the great majority of species of *Partula* whose nature and history completely preclude the operation of the factor of human transport.

Snails of this genus almost invariably dwell in the higher areas of vegetation, where humidity is greater than near the shores. They have no means of dispersal other than their own modes of locomotion. Immersion in fresh water soon renders them moribund, while the effect of salt water during even a few minutes is promptly fatal. The animals could not survive the journey from one island to another on rafts of floating vegetation, and they attach so loosely to leaves and branches that they could not be borne by gales from their homes to another island—a mode of dissemination which has been emphasized by some authors.

We are therefore compelled to postulate prior land-connections between islands of the same group and between now-isolated archipelagos to account for the present existence of undoubted relatives upon separated islands. Some of the species of Moorea are closely affiliated and without question have originated in proximate times from a common ancestral stock of this island; we recall the oft-cited example of *Partula olympia* and *Partula mooreana*, as a case in point. But the *pro-olympia-mooreana* stock was itself a relative of the *pro-otaheitana* ancestor of the present highly diversified group of varieties which are now so widely distributed about Tahiti. The segregation of the two ancestral stocks in question must be referred to very ancient times, and it must have antedated the advent into Polynesia of the only possible carriers in the way of human beings. This is certain because a long time must have been required for the differentiation of the two parental series and for their subsequent resolution into the diversified products now existing. The relationship between *Partula tohiveana* of Mooreana and *Partula formosa* of Raiatea has a parallel significance. The peculiar species *Partula exigua* of Moorea is affiliated with *Partula attenuata* of Tahiti and Raiatea; both of these species live upon lofty vegetation in the highest parts of the valleys, and the possibility of human carriage is even less than in other cases.

If human transport had actually occurred, then the frequent visits of natives between Tahiti and Moorea, separated by only eleven miles, would not have left the species of the two islands endemically different, as they are. Raiatea and

Tahaa are enclosed by the same reef and intercommunication on the part of their inhabitants is much closer than in the case of Tahiti and Moorea; yet their forms are entirely distinct, except that *Partula faba* occurs in both in well-distinguished varietal forms.

The constant movement of natives about the various regions of one and the same island, *a fortiori*, would progressively bring about a more uniform distribution of species and varieties if human transport were actually responsible for the dissemination of Partulæ. Yet *Partula olympia* and *Partula tohiveana* inhabit sharply restricted localities, where the remains of the foundations of ancient dwellings and stone implements prove the former existence of large and thriving human populations. The area of Moorea inhabited by *Partula suturalis strigosa* lies between the Vaiare sector on the east and the Vaianai sector on the west, in both of which *Partula suturalis vexillum* occurs. Not a single day passes without human communication between this area and the contiguous regions; yet *strigosa* is as sharply confined to its sector as though it were located on another island.

The only tenable conclusion to be drawn from the accumulated facts is that the distribution of the species and varieties throughout Moorea is completely accounted for by local differentiation among the members of ancient stocks, more or less disseminated by their own unaided movements. When a species once established has subsequently expanded its territory, in the way that *Partula aurantia* and others have spontaneously spread in recent years, the process of local diversification has been repeated. The same conclusion holds for the earlier dissemination into now-isolated islands of what are the undoubtedly related offspring of the same ancestors. Former land connections are absolute requisites, in view of the nature of the snails themselves and in the light of the outstanding endemicity of their distribution.

CHAPTER XIV

RÉSUMÉ

INTRODUCTION

The present volume is concerned with the nature and natural history of the land-gasteropods belonging to the genus *Partula* that inhabit Moorea, an island of the Society Group and a near neighbor of Tahiti. Hence this volume is more immediately related to the monograph on the species of Tahiti, although it has been preceded in publication by a study of the forms inhabiting certain of the far-distant Mariana Islands. The main body of the present work describes in detail the ten species which exist in Moorea only, their geographical locations, their varied conditions of internal diversification, their interrelationships and their evolutionary histories. The island was first explored in 1907 and 1909, when large numbers of snails were obtained from most of the larger valleys; in 1919 additional territory was surveyed, and in 1923 and 1924 the whole island was again explored in greater detail. By virtue of these circumstances, it is possible to compare the conditions existing in 1907 and 1909 with those described by Garrett for earlier decades, after the manner of the Tahitian study. In addition, it is possible to prove that real changes took place during the comparatively short time from 1909 to the later years of field study. The material consists of 60,316 adults, 10,280 partly grown individuals, and 45,570 embryonic young dissected out of the gravid adults. It has been procured from over fifty major distinguishable valleys of Moorea, many of which have been analyzed in secondary detail. Consequently the facts of distribution, of structural diversification, and of environmental relations can be examined on the basis of unusually abundant and favorable information.

CHAPTER I

The geography and topography of Moorea are very interesting in themselves and a knowledge of them is obviously essential for a description of the distribution of the species and varieties of the endemic Partulæ. The island is very nearly an equilateral triangle in outline, with a northern border that trends almost exactly east and west, and with the opposite angle to the south. It is approximately ten miles long between the eastern and western points, and a little more than six miles on its meridional axis. The northern portion is indented by two narrow bays, but elsewhere its contours are relatively even. The whole island is volcanic in origin. The most prominent topographical feature is a crescent of massive mountains whose concavity opens toward the north and whose points approach the northeastern and northwestern angles of the island. The greater part of this range comprises the walls of an extensive, long-extinct crater, irregularly sculptured and rising to pinnacles which attain the height of over 4000 feet in the case of Mount Tohivea. The outer slopes of the mountainous crescent descend sharply, and they are more or less deeply eroded so as to form a series of alternating ridges

and valleys. The ecological conditions render the latter favorable as habitations for Partulæ, while the buttresses are forested only at higher levels, and consequently the snails do not exist on the peripheral portions of the descending ridges. The illustrations indicate all of these topographical features and the detailed descriptions give the requisite information for an understanding of the areas inhabited by the several species of the island.

CHAPTER II

The collections from Moorea comprise representatives of ten distinct species; three of these have long been known to science, while the other seven have come to light in the course of the present intensive investigations of Moorea. These species differ greatly as regards the extent of the occupied territory as well as in their conditions of internal differentiation. They are treated in the present volume in an order that begins with the simplest in nature and in areal extension, and that proceeds systematically to the most widely spread and the most complex. A comprehensive census table records all of the individuals entering into the discussion.

New species here described for the first time are *Partula solitaria*—which is represented by a single specimen only—*Partula exigua*, and *Partula aurantia*. Other newly discovered species have been specially noticed in advance of their detailed description in the present work; they are *Partula mirabilis*, *Partula tohiveana*, *Partula olympia* and *Partula dendroica*. All of the foregoing had escaped the notice of Garrett and of other collectors in Moorea, mainly because they dwelt in remote and restricted regions, although some of them have definitely enlarged their territories since Garrett's time. The long-known species are *Partula mooreana* Hartman, *Partula suturalis* Pfeiffer and *Partula tæniata* Mörch. The last named is universal in its occurrence and is the most complex species of the whole array, comprising no less than six well-demarcated primary varieties; five of these were earlier described as distinct species, while one is herein named for the first time.

The methods of analysis and description are the same as in the previously published studies. The quantitative and qualitative characters of the species are defined as accurately as possible for the sake of distinctions that would escape observation otherwise. Where a species is represented by isolated colonies these are compared in detail. The embryonic material is particularly valuable for problems of inheritance and interrelationship, as well as for the demonstration of episodes of differentiation in the way of mutations. Throughout the entire volume the question of a factorial environment has been kept well to the fore, although all efforts to discover real effects of external conditions have proved futile.

CHAPTER III

A single specimen of a unique type came to light in 1923 in a collection from a remote subdivision of the large valley of Faatoai, situated in the northeastern part of Moorea. This snail is here described for the first time as *Partula solitaria*. It is clearly distinguished from its associates in the way of *Partula tæniata nucleola*, which varies considerably, it is true, but never in the direction of the unique shell;

the novel individual can not be regarded as a mutant derived from a parent belonging to the prevalent variety of *Partula tæniata*. The general form, the flattened terminal whorl and the open umbilicus are outstanding distinctions, while a character of greater peculiarity is the internal sculpturing of the shell. Furthermore, the egg-capsule is unusually large, and it is equaled in relative size only by the embryonic products of *Partula fragilis* of Guam. In the nature of the case, there are no data of variation. The problem of interrelationships must await the time when a satisfactory representative series of this species may be obtained.

CHAPTER IV

Another species described for the first time is *Partula exigua*, which exists in relatively sparse numbers in a series of more or less contiguous valleys of the northeastern part of Moorea; its range corresponds almost exactly with that of *Partula tæniata striolata*. The animals live in the highest portions of the valleys and on lofty vegetation only, thus agreeing with the members of the interesting species *Partula attenuata* of Tahiti and Raiatea. In general structure this species somewhat resembles *Partula tæniata elongata*, but careful study reveals its real distinction. The shell is especially thin and the name has been chosen on this account. Despite the small numbers available for biometric comparisons, some slight differences among the colonies are demonstrated. Three color classes are distinguished, namely, light corneous (**pallida**), dark brown (**brunea**), and banded types (**frenata**) of a pattern that recurs in many of the other species of the island. The relative numbers of the color components differ from one locality to another but without relation to any discoverable environmental circumstance and without any parallel to color variation in associated species. No annual comparisons are possible in this case. If the general resemblances to *Partula attenuata* in structure and habit indicate real phyletic affinities with that species, as I believe, the existence of *Partula exigua* in Moorea tells strongly in favor of the theory of subsidence. The factor of possible human transport is clearly eliminated, and the occurrence of true relatives in the islands of Tahiti, Moorea and Raiatea is conceivable only if these areas were formerly connected by high and forested land over which the ancestral stock ranged continuously. After the bridges had been submerged, the earlier stock became changed into the existing *Partula exigua* of Moorea, while its representatives remaining in Tahiti and Raiatea retained the original characters of the parent, and hence their products still resemble one another so closely as to be referable to one and the same species.

CHAPTER V

The first discovery of *Partula tohiveana* was made in the course of the intensive explorations of 1923, near the inner or northward base of the lofty pinnacle of Mount Tohivea, and additional collections were secured in 1924. Its area of habitation is small and sharply defined, although there are no ecological conditions which constitute boundaries, as the continuous distribution of the associated species, *Partula suturalis* and *Partula tæniata*, clearly demonstrates. The species is exclusively sinistral like *Partula olympia* and *Partula dendroica* of the same island.

It escaped the observation of Garrett on account of its secluded habitation; and as it came to light only during the later period of study in Moorea, there is no opportunity to compare its then condition with an earlier state of affairs, either in 1907 or in the decades of Garrett's careful work. The shells are large and possess well-defined distinctive characters of form and proportions and coloration. They differ throughout the area of occupation, small though this is, both in morphological respects and in the proportions of the component color classes. The distinctive stripes of the fasciated shells appear only during post-embryonic life. A single mutant dwarf was found which differed markedly from even the smallest among the numerous variants of the colony.

The whole isolated association of *Partula tohiveana* is apparently of considerable age, and it must be regarded as a small relic of what must have been a widely distributed population in remote times. On account of its marked contrasts, it can not be deemed a derivative or a close relative of any other species of Moorea. It really resembles species of the island of Raiatea in such ways as to leave little doubt that it is a product of a common ancestral stock which ranged not only over the present land-masses of Moorea and Raiatea but also over a connecting isthmus formerly above the surface of the sea.

CHAPTER VI

Like the foregoing, the sinistral species *Partula olympia* is a discovery of the later years of the present investigation. It is also similar in the fact that it exists today as a single compact colony in the secluded upper portion of Mouaputa Valley, near the foot of the mountain of the same name. Interest centers around its specific distinctions and its diversification within the limits of variation in size, shape and color. The present species is isolated from all others of the island, especially by its combined characters of coloration, although some of its patterns are duplicated elsewhere. The existence of five distinct color classes, like the amplitude of structural variation, indicates a considerable age of the species as such. The distinctive zone of deep color of the **cestata** class appears on the apical whorls, only to disappear or to be continued with diminished intensity on the later-added whorls, while the two embryonic bands of color of **frenata** increase in strength and definition on the post-embryonic coils. The shells are smaller than in *Partula tohiveana,* shorter and stouter than in *Partula suturalis.* In general they are sufficiently similar to those of *Partula mooreana* to warrant the conclusion that the two species have originated from the same parental stock. Their relatives have completely disappeared from the territory intervening between the single valley of Mouaputa where *Partula olympia* now exists and the larger series of valleys in the central part of Moorea inhabited by *Partula mooreana.* The affiliated species in question possess a significance in connection with the problem of subsidence, inasmuch as their nearest relative elsewhere is *Partula otaheitana* of Tahiti. The degree to which *Partula otaheitana* has become differentiated throughout its own island and the divergence of *Partula olympia* from *Partula mooreana* in Moorea indicate that the *pro-otaheitana* stock must have become

segregated from the *pro-olympia-mooreana* progenitor at a very remote time, long before the arrival of the human elements which supposedly might have been responsible for the transport of snails from one area to the other. To account for the affinities in question, a now-submerged land connection between Moorea and Tahiti is an indispensable postulate.

CHAPTER VII

With the next species, *Partula dendroica*, we come to a population which occupies four valleys in the Rotui sector of high ground that stands between the two indenting bays on the north side of the island. This species is another item in the surprisingly long list of sinistral forms existing in Moorea. The four valleys in question are small and contiguous, and hence the whole area of occupation is unitary; yet its boundaries do not coincide with marked ecological limits, and the associated species spread uninterruptedly on all sides. When the colonies are compared on the basis of the statistics relating to morphological characters and on the basis of color composition, they prove to vary distinctly, despite the proximity of the several valleys. As many as seven well-marked color classes are found in this species which interbreed freely as attested by the colors of the embryonic individuals. The foregoing facts indicate that *Partula dendroica* is a long-established species, and they prove further that congenital factors are responsible for the differences among the several colonies, because the sector of habitation is so compact as to exclude the possibility of diverse effective external circumstances.

The nearest relative of *Partula dendroica* is *Partula suturalis*, which spreads throughout all of the habitable valleys of the island except the Rotui sector. The low and relatively dry central basin of Opunohu and Paopao is an ecological feature of long standing, but this area must have been higher and more densely forested at some earlier time when the common progenitors of these two species ranged continuously over the island. As subsidence progressed, those individuals which happened to be isolated in the mountains of the Rotui region differentiated in the direction which has led their descendants to become the present distinct species of *Partula dendroica*.

CHAPTER VIII

The description and analysis of *Partula aurantia* are here given for the first time, for although representatives of the species were obtained during the earliest years of field-work, their nature and affiliations were so problematical as to require more ample material and more extended study. The species occupies several valleys in geographical contiguity, situated in the northwestern part of Moorea, which they share with *Partula suturalis vexillum*, *Partula exigua* and *Partula tæniata striolata*. Nearly 4000 individuals provide the materials for an intensive analysis, which in this case comprises a comparison of the colonies as they existed during the earlier and the later years of exploration, with demonstrated changes during the interval.

While the prevailing mode of coil is dextral, two sinistral mutants were found in two separated localities, and one of these bore reversed young like itself. Aside

from its characteristic colors and color patterns, *Partula aurantia* is distinguished by its small, oblong, beveled aperture, and by a curious pigmented zone within the margin of the creeping foot; the last feature is unique among species of Partulæ, so far as my experience goes.

It would be incredible that Garrett had failed to discover *Partula aurantia* were it not for evidence derived from my own experience that this species has only recently expanded its area of occupation, and that as late as twenty-five or thirty years ago it must have been almost as sharply restricted to the higher portion of Paparoa Valley as *Partula olympia* is today to its secluded locality of upper Mouaputa Valley. Not only has the species enlarged its territory, but it has also undergone considerable diversification in the colonial qualities of structure and coloration.

At first sight, *Partula aurantia* seems to be an ally of *Partula suturalis*, on account of its color and size, although the details of the color-patterns are different. On closer study, however, it proves to be a phyletic relative of *Partula mirabilis* which dwells in certain disconnected areas nearer to the center of the island; the qualities of the aperture and the lip are the clearest indications of its true affinities. We must conclude, therefore, that at an earlier period a common ancestral stock ranged over a considerable portion of the eastern half of Moorea, within the crescent of high mountains, and that this parental stock varied in different localities as every wide-spread species does today. By the disappearance of the central colonies, separate relics were segregated in slowly contracting areas, to become the remnant in Paparoa Valley which developed the distinctions of *Partula aurantia*, and the *pro-mirabilis* stock in a western direction. The evidences are fully recorded that *Partula aurantia*, like *Partula mirabilis*, has come to occupy wider territory in relatively recent decades, and that its more or less isolated colonies have only lately become definitely diversified in various structural and other qualities.

CHAPTER IX

One of the most notable discoveries of the present research is *Partula mirabilis*—a species peculiarly interesting on account of its intrinsic nature, its areal distribution and its phyletic history. It follows the previous species in the adopted order of treatment by virtue of its more ample numbers and wider area of occurrence. The adults number 4631 and are dextral with the exception of twelve reversed mutants discovered in the two valleys of Faataofe and Maramu. The adolescents amount to 438, including one sinistral individual, while the embryonic young, which were old enough to display the coil, numbered 4218, of which 27 were sinistral. The material was procured from eleven separate valleys, during both the earlier and the later periods of field-work. Garrett did not discover this species because in his time it had not yet spread from a contracted area of habitation into the wider territory which it now holds; evidence for this statement is abundant and unassailable. The prior headquarters of the species were located on the inner or crater side of the mountain crescent, near the middle of the island. Migrants have crossed the divide into Vaianai and Oio Valleys, located in the outer circle, and they have also invaded Matapoopoo Valley in the Rotui sector where

they now exist in prodigious numbers far exceeding their combined associates of *Partula tæniata* and *Partula dendroica*.

The biometric records of the measureable qualities and the schedules relating to the varied color classes define the species as a whole, and they show how and to what degrees the individual colonies of the present have come to vary. Each association exhibits its own individual condition in the characters of size and form, in the kinds of color-classes present, in the relative numbers of such components, and in the biometric constants of the contrasted color classes.

The relations of the color characters of the embryonic young to those of their parents are particularly interesting in connection with the problem of free intercrossing. But they are surpassed in importance by the qualities of coil in the exceptional cases of contemporaneous mutation. The adult sinistrals found in two separated localities are assuredly to be referred to dextral ancestors, for they possess identical specific qualities; but direct and conclusive evidence on this point is afforded by the reversed young actually found within dextral parents. While it is true that some of the offspring of the unusual parents reverted to the prevailing dextral condition, those that repeat the mutant sinistral character prove that a changed condition can arise and that it can perpetuate itself without areal isolation. Incidentally a confirmatory case is presented by the bisecta type of coloration, in another category of characters. The most important item in the matter of embryonic characters is a sinistral adult from Faataofe Valley whose brood-pouch contained one sinistral and one dextral young at the same time. This rare instance supplements the list of similar cases discovered in *Partula suturalis* and *Partula mooreana*.

On the whole, *Partula mirabilis* is quite conservative in its characters, for as yet it has not become differentiated into distinct primary varieties. Its affiliations with *Partula aurantia* have been sufficiently discussed in the previous section, together with the reconstruction of its earlier history.

CHAPTER X

Whereas all of the preceding species are new discoveries of the present research, in *Partula mooreana* Hartman we encounter the first of the long-known species. Garrett described it as a sinistral form occurring in Vaianai Valley alone; it has spread in recent decades to other valleys of the outer circle and to adjacent areas across the great mountains located in the inner crescent. Furthermore in a number of well-isolated valleys it has produced dextral mutants which can not be representatives of a directly coiled stock accompanying the prevalent kind, but are entirely independent in origin. Formerly *Partula mooreana* was the sole species of the Society Islands known to be sinistral, although reversed examples of *Partula suturalis* of Moorea, as well as of *Partula otaheitana* and *Partula nodosa* of Tahiti, were on record; today its distinction is shared with *Partula olympia*, *Partula tohiveana and Partula dendroica* of its own island.

The material comprises over 10,000 individuals of all ages, of which nearly 6000 are adults. The detailed tables describe the several colonies in structural

respects and in color composition. Full series were obtained from certain localities both during the earlier and the later periods of field-work, and hence it is possible to demonstrate colonial changes of various kinds and degrees, in several categories of qualities.

Reviewing the condition of *Partula mooreana* as a whole, it appears that in the course of its recent expansion it has reached a stage in advance of *Partula mirabilis* and the other unitary species, inasmuch as the members of the colony of Atimaha Valley are distinctly smaller than their allies elsewhere, in average respects. The degrees to which the characters of the Atimaha population differ from those of the Vaianai or of another association almost justify the designation of the Atimaha series as a distinct primary variety. This would be done were it not for the great amount of overlapping of the curves of variation of the several characters, and for the occurrence of the same peculiar color-type, **cingulata**, in both Vaianai and Atimaha Valleys. The far-flung colonies in the west central territory comprise relatively large individuals, whose collective differences from the general averages are equally definite, even though they are less in degree. The fact remains that a greater degree of colonial diversity has come about during the later history of *Partula mooreana* than is exhibited by the component colonies of such a species as *Partula mirabilis*, whose area of habitation is sensibly equivalent. Thus the condition of the species in its entirety provides a transition to what is displayed by *Partula suturalis* and, *a fortiori*, by *Partula tæniata*.

The general resemblances between *Partula mooreana* and *Partula olympia* indicate their derivation from a common ancestor within the confines of the island of Moorea after its geographical isolation. While *Partula olympia* has persisted in its secluded and disconnected area in such small numbers as to be in danger of complete extinction, the relic of the old stock which remained in Vaianai Valley, where it attained the distinctions of *Partula mooreana*, has gained renewed vigor, it has enlarged its area of occupation, and it has become internally diversified to a marked degree. The still earlier stock from which both of these species have sprung is itself related to the progenitors of the now-numerous varieties that constitute *Partula otaheitana* of the neighboring island—an opinion confidently expressed by Pilsbry in which I concur without reservation. These facts give cumulative support to the theory of subsidence, especially as the degree to which *Partula otaheitana* and the *pro-mooreana-olympia* series have become differentiated points to a time of their segregation which must have long antedated the arrival of human inhabitants in this part of the Pacific Ocean.

CHAPTER XI

The first-known specimens of *Partula suturalis* were collected by Cuming and were described by Pfeiffer in 1855, although their habitat was wrongly recorded at the time. The standing of the species has been unchallenged aside from Garrett's contention, later withdrawn, that it was to be identified as *Partula lineata* Lesson. As regards its abundance, diversification and territorial extension, it stands between *Partula mooreana* and the remaining species, *Partula tæniata*.

The collections of this species are particularly valuable for the problems of variation, distribution and evolution. They comprise 14,640 adults, 5890 adolescents and 12,922 embryonic individuals, or 33,452 in all. They completely represent the populations of the extensive series of valleys in which the species occurs. Furthermore they were obtained from nearly every colony during the earlier and the later years of exploration, thus affording an opportunity to discover changes taking place in the interim; in addition, a comparison with the situation as Garrett described it for his time is instructive in many ways.

The species as a whole is made up of two primary varieties, *Partula suturalis vexillum* and *Partula suturalis strigosa*. The latter includes the colonies of four contiguous valleys of the southeastern part of Moorea where the snails are exclusively dextral, collectively smaller in size and peculiarly pigmented in some of the color classes. The former variety spreads throughout all of the other habitable valleys, with the exception of those of the Rotui sector, some of which are inhabited by the related species, *Partula dendroica*.

In its original headquarters centering about Vaianai Valley, *Partula suturalis vexillum* is now exclusively dextral, where Garrett found a substantial proportion of sinistral individuals in 1875. We find small sinistral components in Oio and Haapiti Valleys, but diminished in 1923 as compared with earlier years. In Uufau Valley, where Garrett found only dextral snails, there is now a mixed population, but the more northward colonies of the outer circle comprise only sinistral members. The same transition from an exclusively dextral to a purely reversed condition is shown by the associations of the central circle of valleys in the direction of the extreme northwest. By way of the inner or crater series of valleys, *Partula suturalis vexillum* has come to extend to the extreme northeast; and while it is always dextral in the valleys proximate to Vaianai, it becomes mixed in Vaiare and entirely sinistral in the more distant territory. Without recalling the details relating to the various colonies, especially important in the case of Uufau, the conclusion is presented that a tide of migration from the original headquarters of *Partula suturalis vexillum* has borne this variety to the most remote areas of the northwest and northeast, that the outer waves of this tide were sinistral in character, and a subsequent change to the direct mode of coil has likewise worked outward from Vaianai Valley. My own observations prove that real colonial changes in the last-named respect have come about during the comparatively brief period from 1907 to 1924.

When the biometric data are analyzed in detail, they show how the colonies differ in structural respects, without any relation to discoverable environmental circumstances. Variations in colonial composition as regards the presence or absence of particular color components and as regards the proportionate numbers of such components are also to be referred to congenital factors solely.

The embryonic material is abundant and it well serves for the study of certain problems of inheritance. It is clear that the members of distinguishable color-classes interbreed freely and that they are not genetically isolated; in the nature of the case a full analysis in Mendelian terms is not possible. As regards the mode of coil, the general rule is that the offspring carried in the brood-pouch of an adult

at one time resemble their parent, but even in the case of an exclusively sinistral or dextral colony an embryo with the opposite form appears as a mutation in rare cases. In mixed colonies like that of Uufau Valley, the rule still holds in general, but at times all of the young found in a reversed snail may be dextral, and *vice versa*. Certain very remarkable instances were found in the colony of Vaiare-Faamaariri Valley, where dextral and sinistral young were present in the brood-pouch at the same time, as in the rare instances recorded in some of the previously described species.

The past history of *Partula suturalis* may be reconstructed with some confidence. The species is affiliated with *Partula dendroica*, from which it differs to a degree that indicates a remote time for the critical episode of segregation among the components of an ancestral stock spread widely throughout Moorea. As a consequence of subsidence, the variants in the direction of *dendroica* were isolated in their particular territory, namely, the Ŕotui sector, while the stock that persisted in the valleys of the main mountain circle contracted its area of habitation until this became a sector of the outer circle of valleys, probably from about Haapiti on the west to Afareaitu on the east. Here the segregation of *Partula suturalis vexillum* and *Partula suturalis strigosa* took place. While the latter has remained confined to the region of its origin, the former has come to spread widely and to vary in numerous colonial respects, although as yet it shows no definite indication of a further resolution into distinct components with the status of primary varieties. The foregoing history is strikingly parallel to that of *Partula aurantia* and *Partula mirabilis*, and to that of *Partula mooreana*.

CHAPTER XII

The array of Moorean species culminates in *Partula tæniata* Mörch which exceeds all others in actual numbers and in its areal distribution, occurring as it does in every habitable locality of the island. Furthermore, it surpasses its associates in Moorea in its complexity, for it is made up of no less than six distinct primary varieties. In its ubiquity, abundance and elaborate internal differentiation, *Partula tæniata* presents an interesting parallel to *Partula otaheitana* of the neighboring island, even though it does not quite equal the latter in the last-mentioned respect. The material of *Partula tæniata* suffices in itself for a complete study of the species problem, and inevitably it has demanded the most labor for its analysis and description; in point of fact the chapter now concisely summarized constitutes approximately one-third of the present volume. The requisite résumé can be little more than a very general statement regarding the nature and significance of this most important species.

Mörch described the original specimens in 1850 from material "purchased from a whale fisher," and he wrongly attributed them to the Fiji Islands. Since that time the species has received much attention from the specialists, among whom Garrett stands out prominently because he described the nature and distribution of the species in his time with some fulness. The collections of the present research comprise more than 32,000 adults, while the supplementary series of adolescents

and embryonic young bring the total representation of the species to more than 58,000. The qualitative and quantitative records in this case are rendered more valuable by the fact that ample series were obtained both during the earlier and the later years of work in Moorea, and also because the areal analysis has been carried even to the subsidiary parts of larger valleys like Faatoai and Vaiare.

The components of the species are *Partula tæniata simulans* Pease, *Partula tæniata striolata* Pease, *Partula tæniata elongata* Pease, *Partula tæniata nucleola* 'Pease' Garrett, *Partula tæniata spadicea* Reeve, and the newly named primary variety *Partula tæniata propinqua*. The describers of *simulans*, *striolata*, *elongata spadicea* and *nucleola* regarded them as full species, but Garrett properly reduced *nucleola* to the status of a primary variety. My own *propinqua* was distinguished by Pilsbry without a definite name.

A review of the structural qualities of these varieties reveals closer degrees of relationships on the part of *nucleola*, *striolata*, *spadicea* and *propinqua*; the variety *simulans* stands between these four and the remaining component, *elongata*. A comprehensive survey of the color characters discloses exactly similar relations. The characters of the several colonies are voluminously recorded in the statistical tables and in such detail as to define accurately the degrees of morphological difference that are correlated with the degrees of geographical isolation or proximity.

Proceeding from the intrinsic qualities of the shells of the several varieties to their areal relations, much of the prior history of the species is elucidated. The variety *elongata* occupies a continuous series of valleys in the central part of the island, on both sides of the mountain range; it has very recently invaded a single valley of the Rotui sector also. The proximate relative *simulans* occurs as one and the same type in two separated regions on either side of the territory of *elongata*, again in valleys of the outer circle and of the inner circle as well; thus it is obvious that at some earlier time *simulans* spread uninterruptedly from west to east and that it has been displaced by *elongata* in the middle zone as a result of the origin and establishment of the newer qualities that characterize the *elongata* component. The other four varieties which are mutually so similar dwell in the well-separated areas of the trident-like northern extremities of the island: *striolata* in the northeast, *nucleola* in the northwest, while *spadicea* and *propinqua* occur in the Rotui sector. In view of their geographical isolation the close resemblances of these four varieties mean that they are derived from an older stock which has been crowded northward into the areas in question by a following wave of *simulans*, just as *simulans* itself has been displaced by the later-established variety, *elongata*.

Four sinistral mutants were found whose extreme rarity may be judged from the fact that the dextral animals of all ages numbered more than 58,000. Two of these were *simulans* from Taapurau Valley, one was an *elongata* from Oio Valley, while the fourth was a *spadicea* from Vaihiaiia Valley. As these three areas are widely separated, it is certain that the episodes of mutation were entirely independent.

With reference to the problem of the possible effects of the environment upon structural or other qualities, the only conclusion warranted by the facts is that

congenital factors are solely responsible for the diversities exhibited by the several varieties, by the numerous colonies, and by the individual components of the colonies. When two distinct varieties occur together, as *simulans* and *striolata* in Vaiare, *propinqua* and *spadicea* in Vaihiaiia, it is manifestly impossible to refer the contrasted conditions to identical surrounding circumstances. The distinctions of *nucleola* are not paralleled in the associated species, nor are those of *striolata* duplicated in any way by *Partula suturalis*, *Partula aurantia* and *Partula exigua* which inhabit the same territory. The four sinistral mutants of this species, like their counterparts in other species, could arise only by congenital mutation. Distinct color varieties of certain colonies and characteristic proportionate values of the several color components also show no evidence of control by external influences. Snails differing in size, form and coloration are to be found on a single leaf. Finally different kinds of embryonic young may be taken from one and the same parental brood-pouch. All of the categories of fact illustrated by these few citations, as well as by all of the information regarding other species, provide cumulative proof for the congenital determination of the characteristics of the snails with which the present investigation is concerned.

CHAPTER XIII

The main body of the present volume comprises the special chapters on the individual species of Moorea which have been summarized in concise form in order that the points of special significance might be emphasized. In Chapter XIII the ten species of Moorea are then treated in a comprehensive way with interest centered upon matters of interspecific relationship and evolutionary dynamics, so far as the latter may be elucidated by studies of the present nature. As this summary discussion is itself a résumé, it is not desirable to offer a more condensed statement of its substance and conclusions. Each of its sections might well be expanded to far greater compass. As the species of Partulæ from other islands and groups are brought into the record, it will be necessary to add similar discussions which will bring the new materials into their proper relations within the whole scheme of the investigation. While the chapter in question fails to do full justice to the various aspects of the problem of organic differentiation in nature, yet it indicates in outline at least how the material of the research serves for a fuller understanding of the geographical distribution, variation and evolution of the species of the genus *Partula*.

TABLE 24—*Partula exigua. Statistical description*

Series	Year	No.	Shell			Aperture			Length aperture + length shell, proportions
			Length	Width	Proportions	Length	Width	Proportions	
			mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Range (class values)									
Vaiare-Puutu	1907	1	16.85	8.9	52.5	9.1	6.1	67.5	53.5
Vaiare-Faamaariri (A)	1923	3	15.35 – 16.85	8.5 – 8.7	52.5 – 55.5	8.5 – 9.1	6.1	66.5 – 71.5	52.5 – 56.5
Vaiare-Faamaariri	1924	15	13.55 – 16.55	8.1 – 9.3	53.5 – 61.5	7.3 – 9.3	5.3 – 6.3	66.5 – 76.5	52.5 – 57.5
Tepu	1919	12	12.95 – 15.65	7.7 – 8.9	55.5 – 60.5	7.5 – 9.3	5.3 – 6.3	67.5 – 74.5	52.5 – 59.5
Maharepa	1907	2	15.05 – 16.25	8.3 – 9.1	55.5	7.9 – 8.7	5.7 – 6.1	68.5 – 72.5	52.5 – 53.5
Maharepa	1923	24	12.65 – 16.55	7.5 – 9.5	54.5 – 61.5	7.7 – 9.3	5.3 – 6.5	67.5 – 74.5	53.5 – 59.5
Paraoro middle	1909	5	14.15 – 15.65	8.3 – 9.1	55.5 – 64.5	8.1 – 8.9	5.9 – 6.1	68.5 – 74.5	53.5 – 57.5
Paraoro middle	1923	23	14.15 – 17.45	8.1 – 9.3	51.5 – 57.5	8.1 – 9.7	5.7 – 6.7	67.5 – 73.5	52.5 – 59.5
Paraoro south	1923	24	14.45 – 16.55	8.3 – 9.7	52.5 – 62.5	8.1 – 9.3	5.7 – 6.9	67.5 – 75.5	52.5 – 58.5
All	....	109	12.65 – 17.45	7.5 – 9.7	51.5 – 64.5	7.3 – 9.7	5.3 – 6.9	66.5 – 76.5	52.5 – 59.5
Mean value									
Vaiare-Puutu[1]	1907	1	16.85	8.9	52.5	9.1	6.1	67.5	53.5
Vaiare-Faamaariri (A)	1923	3	16.0500 ± 0.2400	8.5666 ± 0.0367	53.5000 ± 0.5507	8.8333 ± 0.0971	6.1000 ± 0.0	69.1666 ± 0.8002	54.1666 ± 0.6619
Vaiare-Faamaariri	1924	15	14.8700 ± .1386	8.5800 ± .0620	57.7000 ± .2858	8.1533 ± .0876	5.7666 ± .0549	70.8333 ± .4953	54.7000 ± .2479
Tepu	1919	12	14.4500 ± .1431	8.3833 ± .0625	57.8333 ± .3112	8.1000 ± .0940	5.7833 ± .0538	71.0833 ± .3415	56.0000 ± .3268
Maharepa	1907	2	15.6500 ± .2861	8.7000 ± .1908	55.5000 ± .0	8.3000 ± .1908	5.7000 ± .0954	70.5000 ± .9539	53.0000 ± .2384
Maharepa	1923	24	15.0000 ± .1057	8.5250 ± .0552	56.7916 ± .2265	8.3583 ± .0473	5.9250 ± .0408	70.6666 ± .2596	55.6666 ± .2201
Paraoro middle	1909	5	15.2300 ± .1773	8.7800 ± .0903	57.7000 ± 1.0518	8.4600 ± .0886	6.0200 ± .0120	69.9000 ± .7035	55.5000 ± .4266
Paraoro middle	1923	23	15.8495 ± .1167	8.6131 ± .0460	54.4566 ± .2858	8.8304 ± .0566	6.1522 ± .0344	69.5870 ± .1985	55.8042 ± .2362
Paraoro south	1923	24	15.3250 ± .0899	8.9166 ± .0533	58.0416 ± .3026	8.6250 ± .0501	6.1583 ± .0453	71.1666 ± .2965	55.9583 ± .2243
All	....	109	15.2344 ± .0565	8.6413 ± .0255	56.7019 ± .1591	8.4835 ± .0309	5.9973 ± .0208	70.6284 ± .1406	55.5642 ± .1095
Standard deviation									
Vaiare-Puutu	1907	1	.....	.....	.....	.....	.....	.....	.....
Vaiare-Faamaariri (A)	1923	3	0.6164 ± 0.1697	0.0943 ± 0.0259	1.4142 ± 0.3894	0.2494 ± 0.0687	0.	2.0548 ± 0.5658	1.6997 ± 0.4687
Vaiare-Faamaariri	1924	15	.7960 ± .0980	.3563 ± .0438	1.6411 ± .2021	.5031 ± .0619	.3155 ± 0.0388	2.8441 ± .3502	1.4236 ± .1753
Tepu	1919	12	.7348 ± .1012	.3210 ± .0442	1.5986 ± .2200	.4830 ± .0664	.2764 ± .0380	1.7539 ± .2415	1.6783 ± .2311
Maharepa	1907	2	.6000 ± .2023	.4000 ± .1349	0.	.4000 ± .1349	.2000 ± .0675	2.0000 ± .6745	0.5000 ± .1686
Maharepa	1923	24	.7681 ± .0748	.4013 ± .0391	1.6452 ± .1602	.3439 ± .0335	.2962 ± .0289	1.8856 ± .1836	1.5986 ± .1557
Paraoro middle	1909	5	.5879 ± .1254	.2993 ± .0638	3.4871 ± .7437	.2939 ± .0626	.0400 ± .0085	2.3324 ± .4974	1.4142 ± .3016
Paraoro middle	1923	23	.8297 ± .0825	.3275 ± .0325	2.0319 ± .2021	.4027 ± .0400	.2447 ± .0243	1.4116 ± .1403	1.6794 ± .1670
Paraoro south	1923	24	.6533 ± .0635	.3870 ± .0377	2.1981 ± .2140	.3643 ± .0354	.3290 ± .0320	2.1538 ± .2096	1.6294 ± .1586
All	....	109	.8752 ± .0399	.3957 ± .0180	2.4621 ± .1125	.4802 ± .0218	.3224 ± .0147	2.1762 ± .0994	1.6944 ± .0744

[1] Class values.

TABLE 25—*Partula exigua. Statistics of fecundity*

Series	Records	Gravid	Per cent gravid	Eggs	Young	Total contents	Average for gravid	Average for all
Vaiare-Puutu, 1907	1	1	100.	2	2	4	4.00	4.00
Vaiare-Puutu, 1919	2	1	50.	..	1	1	1.00	0.50
Vaiare-Faamaariri (A), 1923	5	5	100.	10	7	17	3.40	3.40
Vaiare-Faamaariri (B), 1923	4	3	75.	10	4	14	4.66	3.50
Vaiare-Faamaariri, 1924	23	17	73.91	26	16	42	2.47	1.82
Tepu, 1919	14	9	64.28	4	11	15	1.66	1.07
Maharepa, 1907	2	1	50.	1	1	2	2.00	1.00
Maharepa, 1923	39	36	92.31	43	36	79	2.19	2.02
Paraoro middle, 1909	6	4	66.66	5	..	5	1.25	0.83
Paraoro middle, 1923	30	28	93.33	43	27	70	2.50	2.33
Paraoro south, 1923	27	20	74.07	33	10	43	2.15	1.59
All	153	125	81.70	177	115	292	2.33	1.91

TABLE 26—*Partula exigua. Recorded adults and their embryonic contents*

Number of eggs	Number of young				Totals
	0	1	2	3	
0	28	8	2	..	38
1	19	29	10	2	60
2	17	23	8	1	49 (177 eggs)
3	1	3	1	..	5
4	..	1	..	..	1
Totals	65	64	21	3	153
		115 young			

Summary	Embryonic contents					
	0	1	2	3	4	5
Number of adults: 153	28	27	48	34	13	3

TABLE 27—*Partula tohiveana. Statistical description*

Series	No.	Shell						Aperture						Length aperture + length shell, proportions	
		Length		Width		Proportions		Length		Width		Proportions			
		mm.		*mm.*		*p. ct.*		*mm.*		*mm.*		*p. ct.*		*p. ct.*	
Lower	39	20.15	−23.75	10.9	−13.3	49.5	−59.5	10.7	−12.5	7.3	−9.3	66.5	−77.5	47.5	−53.5
Middle	197	17.45	−23.45	10.1	−13.7	51.5	−60.5	8.9	−12.3	6.7	−8.9	65.5	−78.5	47.5	−55.5
Upper	317	18.65	−24.35	10.7	−13.7	47.5	−62.5	9.9	−12.5	7.1	−8.9	65.5	−78.5	46.5	−58.5
Whole series	553	17.45	−24.35	10.1	−13.7	47.5	−62.5	8.9	−12.5	6.7	−9.3	65.5	−78.5	46.5	−58.5
Mean value															
Lower, inornata	28	22.2601	± 0.1001	12.3500	± 0.0622	55.3929	± 0.2632	11.3214	± 0.0575	8.2143	±0.0522	72.5714	± 0.2747	50.6786	± 0.2236
frenata	11	22.3045	± .2045	12.1363	± .1066	54.2273	± .4075	11.3909	± .0763	8.2273	± .0905	72.0455	± .6848	51.1363	± .2494
All	39	22.2731	± .0881	12.2897	± .0522	55.0641	± .2171	11.3410	± .0441	8.2179	± .0431	72.4231	± .2672	50.8077	± .1661
Middle, inornata	154	21.5487	± .0437	12.0481	± .0251	55.8766	± .1064	10.9961	± .0174	7.9169	± .0176	71.9221	± .1276	50.9870	± .0874
frenata[1]	42	21.6357	± .1081	12.0048	± .0543	55.4524	± .1858	11.0381	± .0548	7.9857	± .0414	72.0953	± .2237	51.0000	± .1404
cestata	1	22.25		12.10		53.50		11.10		8.30		73.50		49.50	
All	197	21.5708	± .0413	12.0391	± .0228	55.7741	± .0928	11.0056	± .0212	7.9335	± .0164	71.9771	± .1108	50.9822	± .0748
Upper, inornata simplex	141	21.8153	± .0527	12.2773	± .0262	56.3085	± .1175	11.1709	± .0285	7.9440	± .0205	70.9185	± .1321	51.1666	± .1045
inornata apex	122	21.7607	± .0561	12.1475	± .0324	55.8033	± .1356	10.0836	± .0296	7.9295	± .0220	71.5082	± .1539	50.8360	± .1012
frenata simplex	25	21.8060	± .1110	12.3000	± .0656	56.3800	± .2422	11.2040	± .0736	8.0520	± .0508	71.6200	± .4356	51.0200	± .2261
frenata apex	29	21.6500	± .1186	12.1896	± .0545	56.0862	± .2428	11.1896	± .0532	8.1207	± .0350	72.1207	± .3179	52.5344	± .1594
All	317	21.7740	± .0348	12.2211	± .0188	56.0994	± .0800	11.1416	± .0187	7.9631	± .0136	71.3113	± .0959	51.0615	± .0654
Whole series	553	21.7368	± .0260	12.1611	± .0142	55.9105	± .0591	11.1072	± .0137	7.9705	± .0104	71.6230	± .0711	51.0154	± .0475
Standard deviation															
Lower, inornata	28	0.7282	± 0.0708	0.4524	± 0.0440	1.9149	± 0.1861	0.4186	± 0.0406	0.3796	±0.0369	1.9987	± 0.1942	1.6269	± 0.1581
frenata	11	1.0057	± .1446	.5244	± .0754	2.0041	± .2881	.3753	± .0539	.4453	± .0640	3.3673	± .4842	1.2263	± .1763
All	39	.8163	± .0623	.4835	± .0369	2.0101	± .1535	.4081	± .0312	.3993	± .0305	2.4743	± .1889	1.5384	± .1174
Middle, inornata	154	.8041	± .0309	.4619	± .0177	1.9576	± .0752	.3203	± .0123	.3239	± .0124	2.3489	± .0902	1.6086	± .0618
frenata	42	1.0391	± .0764	.5224	± .0384	1.7855	± .1314	.5264	± .0387	.3979	± .0293	2.1499	± .1582	1.3496	± .0903
cestata	1														
All	197	.8604	± .0291	.4747	± .0161	1.9318	± .0656	.4408	± .0150	.3424	± .0116	2.3054	± .0783	1.5563	± .0529
Upper, inornata simplex	141	.9287	± .0372	.4613	± .0185	2.0694	± .0831	.5026	± .0201	.3605	± .0145	2.3252	± .0934	1.8399	± .0739
inornata apex	122	.9196	± .0396	.5310	± .0229	2.2209	± .0959	.4856	± .0209	.3600	± .0155	2.5204	± .1088	1.6576	± .0715
frenata simplex	25	.8232	± .0785	.4866	± .0464	1.7959	± .1712	.5459	± .0520	.3764	± .0359	3.2289	± .3207	1.6762	± .1599
frenata apex	29	.9474	± .0838	.4350	± .0385	1.9390	± .1717	.4253	± .0376	.2796	± .0247	2.5381	± .2248	1.2727	± .1127
All	317	.9196	± .0246	.4932	± .0132	2.1121	± .0565	.4953	± .0132	.3599	± .0096	2.5325	± .0678	1.7257	± .0462
Whole series	553	.9089	± .0184	.4947	± .0100	2.0613	± .0418	.4794	± .0097	.3635	± .0073	2.4787	± .0503	1.6558	± .0336

[1] Class values.

TABLE 28—*Partula tohiveana. Statistics of tooth-development*

Series	Index					Total	Average
	1	2	3	4	5		
Lower, inornata	....	5	13	8	5	31	....
frenata	....	1	10	7	1	19	....
All	....	6	23	15	6	50	3.4200
Middle, inornata	....	56	62	38	19	175	....
frenata	....	17	20	8	7	52	....
cestata	....	....	....	1	....	1	....
All	....	73	82	47	26	228	3.1690
Upper, inornata simplex	....	51	96	24	8	179	....
inornata apex	....	48	80	15	3	146	....
frenata simplex	....	7	16	7	5	35	....
frenata apex	....	14	17	7	2	40	....
All	....	120	209	53	18	400	2.8151
Whole series	....	199	314	115	50	678	3.0236

TABLE 29—*Partula tohiveana. Statistics of fecundity*

Series	Records	Gravid	Per cent gravid	Eggs	Young	Total contents	Average for gravid	Average for all
Lower, inornata simplex	10	9	90.0	11	10	21	2.33	2.10
inornata apex	20	19	95.0	26	25	51	2.68	2.55
frenata simplex	10	10	100.	10	15	25	2.50	2.50
frenata apex	8	8	100.	9	11	20	2.50	2.50
Middle, inornata simplex	79	68	86.1	60	94	154	2.26	1.95
inornata apex	89	75	84.2	81	97	178	2.37	2.00
frenata simplex	17	14	82.3	16	20	36	2.57	2.12
frenata apex	32	20	62.5	26	26	52	2.60	1.62
cestata	1	1	100.	0	2	2	2.00	2.00
Upper, inornata simplex	169	150	88.7	165	157	322	2.15	1.90
inornata apex	139	116	83.4	145	111	256	2.12	1.84
frenata simplex	34	31	91.2	33	31	64	2.06	1.88
frenata apex	38	32	84.2	40	28	68	2.12	1.79
Whole series	646	553	85.6	622	627	1249	2.26	1.93

TABLE 30—*Partula tohiveana. Recorded adults and their embryonic contents*

Number of eggs	Number of young				Totals
	0	1	2	3	
0	93	27	27	1	148
1	61	179	133	3	376 } 622
2	45	63	11	1	120 } eggs
3	1	1	..	..	2 }
Totals	200	270	171	5	646 records
		627 young			

Summary	Embryonic contents					
	0	1	2	3	4	5
Number of adults—646	93	88	251	198	15	1

TABLE 31—*Partula tohiveana. Statistics of heredity of the color-order distinctions*

	simplex young	apex young	Total
Adults:			
simplex	227	100	327 (52 per cent)
apex	143	157	300 (48 per cent)
Total	370 (59 per cent)	257 (41 per cent)	627

TABLE 32—*Partula olympia, Mouaputa Valley. Statistical description*

Series	No.	Shell						Aperture						Length aperture ÷length shell, proportions	
		Length		Width		Proportions		Length		Width		Proportions			
		mm.		*mm.*		*p. ct.*		*mm.*		*mm.*		*p. ct.*		*p. ct.*	
Range (class values)															
Aug. 25, 1919	3	18.35	−19.55	10.9	−12.1	58.5	−62.5	10.1	−10.5	7.1	−8.1	71.5	−77.5	53.5	−54.5
Aug. 27, 1919															
cestata vera	13	17.75	−20.15	10.3	−11.5	53.5	−62.5	9.3	−10.5	6.7	−7.9	70.5	−77.5	49.5	−55.5
cestata helix	11	18.05	−19.85	10.3	−11.3	56.5	−61.5	9.1	−10.5	7.1	−7.7	72.5	−80.5	50.5	−55.5
cornea	5	18.95	−20.45	10.7	−11.7	54.5	−60.5	9.9	−10.5	7.3	−7.7	72.5	−74.5	49.5	−51.5
frenata	2	18.65	−19.85	10.7	−11.9	57.5	−60.5	10.5	−10.9	7.7	−8.1	72.5	−74.5	54.5	−56.5
All	31	17.75	−20.45	10.3	−11.9	53.5	−62.5	9.3	−10.9	6.7	−8.1	70.5	−81.5	49.5	−56.5
Whole series	34	17.75	−20.45	10.3	−12.1	53.5	−62.5	9.3	−10.9	6.7	−8.1	70.5	−81.5	49.5	−56.5
Mean value															
Aug. 25, 1919	3	19.0500	± 0.1985	11.5000	± 0.1908	60.1666	± 0.6619	10.3666	± 0.0734	7.7000	±0.1682	74.8333	± 0.9713	54.1666	± 0.1836
Aug. 27, 1919															
cestata vera	13	18.7193	± .1059	10.9254	± .0740	58.2693	± .3823	9.9000	± .0568	7.3769	± .0559	74.1923	± .4486	52.8077	± .2684
cestata helix	11	18.7864	± .1116	10.9546	± .0696	58.5000	± .3575	9.9000	± .0715	7.4091	± .0318	74.9545	± .4367	52.5909	± .3409
cornea	5	19.7300	± .1678	11.1800	± .0980	56.7000	± .6152	10.1400	± .0886	7.4600	± .0451	73.9000	± .2413	51.1000	± .2413
frenata	2	19.2500	± .2861	11.3000	± .2861	59.0000	± .7154	10.7000	± .0954	7.9000	± .0954	73.5000	± .4769	55.5000	± .4769
All	31	18.9403	± .0812	10.9968	± .0488	58.1452	± .2453	9.9903	± .0456	7.4355	± .0316	74.3710	± .2551	52.6290	± .2081
Whole series	34	18.9500	± .0762	11.0353	± .0507	58.5294	± .2389	10.0235	± .0438	7.4588	± .0335	74.4118	± .2483	52.7647	± .1970
Standard deviation															
Aug. 25, 1919	3	0.5099	± 0.1403	0.4899	± 0.1349	1.6997	± 0.4680	0.1886	± 0.0519	0.4320	±0.1189	2.4944	± 0.6868	0.4714	± 0.1298
Aug. 27, 1919															
cestata vera	13	0.5662	± .0749	0.3958	± .0523	2.0439	± .2703	0.3038	± .0401	.2991	± .0395	2.3982	± .3172	1.4349	± .1898
cestata helix	11	.5491	± .0789	.3421	± .0492	1.7578	± .2528	.3516	± .0505	.1564	± .0225	2.1475	± .3088	1.6763	± .2410
cornea	5	.5564	± .1186	.3249	± .0693	2.0396	± .4350	.2939	± .0626	.1496	± .0319	0.8000	± .1706	0.8000	± .1706
frenata	2	.6000	± .2023	.6000	± .2023	1.5000	± .5058	.2000	± .0674	.2000	± .0674	1.0000	± .3372	1.0000	± .3372
All	31	.6707	± .0574	0.4028	± .0345	2.0248	± .1734	.3762	± .0322	.2609	± .0223	2.1059	± .1804	1.7179	± .1471
Whole series	34	.6589	± .0531	0.4385	± .0358	2.0655	± .1689	.3789	± .0311	.2901	± .0237	2.1468	± .1756	1.7031	± .1393

TABLE 33—*Partula olympia. Statistics of tooth development*

Series	Index					Total	Average
	1	2	3	4	5		
Aug. 25, 1919	..	2	1	1	..	4	2.7500
Aug. 27, 1919	4	27	13	3	..	47	2.3191
All	4	29	14	4	..	51	2.3529

TABLE 34—*Partula olympia, Mouaputa Valley. Fecundity*

Series	Records	No. of gravid	Per cent gravid	No. of eggs	No. of young	Total contents	Average for gravid	Average for all
Aug. 25, 1919	4	3	75.0	5	3	8	2.66	2.00
Aug. 27, 1919								
cestata vera	18	15	83.3	21	14	35	2.33	1.94
cestata helix	17	14	82.3	10	16	26	1.86	1.53
cornea	5	4	80.0	5	5	10	2.50	2.00
castanea	1	1	(100)	...	1	1	1.00	1.00
frenata	4	4	100	2	5	7	1.75	1.75
All	45	38	84.4	38	41	79	2.08	1.75
Whole series	49	41	83.7	43	44	87	2.12	1.77

TABLE 35—*Partula olympia. Recorded adults and their embryonic contents*

Number of eggs	Number of young			
	0	1	2	
0	8	7	2	17
1	5	10	7	22
2	2	5	1	9
3	....	1	...	1
				43 young.
Totals	15	24	10	49 records.
		44 young		

Summary	Embryonic contents				
	0	1	2	3	4
Number of adults—49	8	12	14	13	2

TABLE 36—*Partula olympia. Statistics of heredity of coloration*

Adult series	Banded young	Unbanded young	Total young
Aug. 25, 1919			
cestata	2	...	2
cornea	1	...	1
Aug. 27, 1919			
cestata vera	11	3	14
cestata helix	14	2	16
cornea	1	4	5
castanea	1	...	1
frenata	3	2	5
All	30	11	41
Whole series	33	11	44

Summary

	All adults	Adults with young	Embryonic young
Banded spire, cestata class	38 74.5 per cent	26 76.5 per cent	33 75.0 per cent
Unbanded spire, other classes	13 25.5 per cent	8 23.5 per cent	11 25.0 per cent
Total	51	34	44 .....

TABLE 37—*Partula dendroica. Statistical description*

Series	No.	Shell						Aperture						Length aperture ÷length shell, proportions	
		Length		Width		Proportions		Length		Width		Proportions			
		mm.		*mm.*		*p. ct.*		*mm.*		*mm.*		*p. ct.*		*p. ct.*	
Range (class values)															
Vaihiaiia, north, 1924	15	19.55	−22.55	10.7	−12.5	49.5	−58.5	10.1	−11.7	7.5	−9.3	71.5	−81.5	48.5	−55.5
Vaihiaiia, middle, 1909	9	19.25	−21.95	10.7	−11.9	50.5	−61.5	10.1	−11.3	7.7	−8.5	72.5	−77.5	48.5	−58.5
Vaihiaiia, south, 1923	15	19.25	−22.25	10.9	−12.3	51.5	−61.5	10.3	−11.7	7.7	−8.7	72.5	−81.5	49.5	−54.5
Matapoopoo, west, 1923	3	20.15	−21.05	10.9	−11.1	52.5	−54.5	10.3	−10.9	7.5	−8.3	70.5	−76.5	51.5	−52.5
Matapoopoo, middle, 1919	13	19.85	−21.95	10.9	−11.7	50.5	−56.5	10.1	−11.5	7.5	−8.5	66.5	−80.5	47.5	−55.5
Tepatu, 1923	16	19.85	−23.45	10.3	−12.5	46.5	−60.5	9.9	−11.5	7.1	−8.9	69.5	−78.5	46.5	−56.5
Pupuhi-Teviroa, 1923	30	18.95	−21.65	10.7	−12.1	51.5	−60.5	9.9	−11.5	7.3	−8.9	71.5	−80.5	48.5	−55.5
All	101	18.95	−23.45	10.3	−12.5	46.5	−61.5	9.9	−11.7	7.1	−9.3	66.5	−81.5	46.5	−58.5
Mean value															
Vaihiaiia, north, 1924	15	20.7100	± 0.1548	11.3133	± 0.0903	54.6333	± 0.4108	10.7533	± 0.0819	8.2600	±0.0775	76.7666	± 0.5145	51.7666	± 0.3174
Vaihiaiia, middle, 1909	9	20.6166	± .1808	11.2778	± .0777	54.9444	± .7274	10.8778	± .0805	8.0333	± .0519	73.8333	± .3671	52.8333	± .7266
Vaihiaiia, south, 1923	15	20.4100	± .1438	11.5666	± .0631	56.3667	± .4445	10.7266	± .0751	8.1800	± .0536	76.1667	± .4202	52.3000	± .2559
Matapoopoo, west, 1923	3	20.6500	± .1457	10.9666	± .0367	53.1666	± .3671	10.7000	± .1101	7.8333	± .1323	73.5000	± .9539	51.8333	± .1836
Matapoopoo, middle, 1919	13	20.8192	± .1126	11.3000	± .0487	54.1154	± .3560	10.9615	± .0725	8.1154	± .0474	73.9615	± .6338	52.5000	± .3741
Tepatu, 1923	16	20.8625	± .1537	11.3125	± .0964	54.2500	± .5795	10.7000	± .0631	8.0500	± .0710	75.1250	± .4456	51.2500	± .3699
Pupuhi-Teviroa, 1923	30	20.0300	± .0937	11.1733	± .0443	55.8000	± .2170	10.6400	± .0450	8.0200	± .0415	75.3000	± .2511	53.1666	± .1990
All	101	20.4856	± .0576	11.2941	± .0291	55.0941	± .1730	10.7436	± .0274	8.0921	± .0243	75.2624	± .1820	52.3410	± .1377
Standard deviation															
Vaihiaiia, north, 1924	15	0.8890	± 0.1094	0.5188	± 0.0638	2.1868	± 0.3592	0.4703	± 0.0580	0.4454	±0.0548	2.9545	± 0.3638	1.8427	± 0.2244
Vaihiaiia, middle, 1909	9	.8014	± .1278	.3457	± .0549	3.2356	± .5143	.3583	± .0569	.2309	± .0367	1.6329	± .2595	3.2318	± .5138
Vaihiaiia, south, 1923	15	.8261	± .1017	.3627	± .0446	2.5525	± .3143	.4312	± .0531	.3081	± .0379	2.4129	± .2971	1.4697	± .1809
Matapoopoo, west, 1923	3	.3741	± .1030	.0943	± .0259	0.9428	± .2596	.2828	± .0778	.3399	± .0935	2.4495	± .6745	0.4714	± .1298
Matapoopoo, middle, 1919	13	.6018	± .0796	.2602	± .0344	1.9029	± .2517	.3874	± .0512	.2537	± .0335	3.3881	± .4481	2.0000	± .2645
Tepatu, 1923	16	.9116	± .1087	.5721	± .0681	3.4369	± .4097	.3741	± .0446	.4213	± .0502	2.6428	± .3151	2.1938	± .1201
Pupuhi-Teviroa, 1923	30	.7613	± .0662	.3596	± .0313	1.7626	± .1534	.3657	± .0318	.3370	± .0293	2.0396	± .1775	1.6162	± .1407
All	101	.8586	± .0407	.4337	± .0206	2.5782	± .1133	0.4084	± .0194	0.3625	± .0172	2.7126	± .1287	2.0524	± .0974

TABLE 38—*Partula dendroica. Progressive regional comparisons*

Series	Mean value						
	Shell			Aperture			Length aperture ÷length shell, proportions
	Length	Width	Proportions	Length	Width	Proportions	
	mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Vaihiaiia, north, 1924	(−0.0934±0.2380)	(−0.0355±0.1191)	(+0.3111±0.8338)	(+0.1245±0.1148)	(−0.2267±0.1017)	−2.9333±0.6320	(+1.0667±0.7929)
Vaihiaiia, middle, 1909	(− .2066± .2310)	(+ .2888± .1001)	(+1.4223± .8509)	(− .1512± .1101)	(+ .1467± .0746)	+2.3334± .5580	(− .5333± .7703)
Vaihiaiia, south, 1923	(+ .2400± .2047)	− .6000± .0730	−3.1001± .5765	(− .0266± .1333)	(− .3467± .1428)	(+2.6667±1.0423)	(− .4667± .3149)
Matapoopoo, west, 1923	(+ .1692± .1841)	+ .3334± .0797	(+ .9488± .5114)	(+ .2615± .1318)	(+ .2821± .1405)	(+ .4615±1.1453)	(+ .6667± .4167)
Matapoopoo, middle, 1919	(+ .0423± .1905)	(+ .0125± .1080)	(+ .1346± .6801)	(− .2615± .0966)	(− .0654± .0854)	(+1.1635± .7753)	(−1.2500± .5261)
Tepatu, 1923	− .8325± .1800	(− .1378± .1061)	(+1.5500± .6196)	(− .0600± .0775)	(− .0300± .0822)	(+ .1750± .5220)	+1.9166± .4200
Pupuhi-Teviroa, 1923							

TABLE 39—*Partula dendroica. Statistics of tooth-development*

Series	Index					Total	Average
	1	2	3	4	5		
Vaihiaiia north, 1924	13	2	...	...	...	15	1.1333
Vaihiaiia middle, 1909	6	7	...	...	...	13	1.5385
Vaihiaiia south, 1923	16	1	...	...	...	17	1.0588
Matapoopoo west, 1923	4	2	...	...	...	6	1.3333
Matapoopoo middle, 1919	13	..	...	...	...	13	1.0000
Matapoopoo east, 1923	...	1	...	...	...	1	2.0000
Tepatu, 1923	24	4	...	...	...	28	1.1428
Pupuhi-Teviroa, 1923	33	..	...	...	...	33	1.0000
All	109	17	...	...	...	126	1.1349

TABLE 40—*Partula dendroica. Statistical description of the color classes*

Series	No.	Mean value						
		Shell			Aperture			Length aperture +length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Vaihiaiia, north, 1924, cingulata	12	20.9750±0.1547	11.3500±0.1091	54.0833±0.3931	10.8166±0.0931	8.3166±0.0931	76.7500±0.5899	51.4666±0.3506
apex	2	19.7000± .0705	11.3000± .0954	57.5000± .4769	10.5000± .1908	8.1000± .0	77.5000±1.4308	53.0000± .7054
castanea[1]	1	19.55	9.90	55.50	10.50	7.90	75.50	53.50
Vaihiaiia, north, 1924, all	15	20.7100± .1548	11.3133± .0903	54.6333± .4108	10.7533± .0819	8.2600± .0775	76.7666± .5145	51.7666± .3174
Vaihiaiia, middle, 1909, cingulata	4	20.7500± .3278	11.3500± .1106	55.0000±1.3594	11.0000± .0584	8.1000± .0826	73.7000± .4410	53.0000±1.1311
fusca	5	20.5100± .1840	11.2200± .1052	54.9000± .7289	10.7800± .1299	7.9800± .0615	73.9000± .5594	52.7000± .9423
Vaihiaiia, middle, 1909, all	9	20.6166± .1808	11.2778± .0777	54.9444± .7274	10.8778± .0805	8.0333± .0519	73.8333± .3071	52.8333± .7266
Vaihiaiia, south, 1923, cingulata	7	20.5357± .2408	11.5000± .0982	55.6429± .6308	10.6714± .1261	8.1000± .0982	75.7857± .6635	51.7857± .4022
zonata	2	19.8500± .1431	11.8000± .2384	59.5000± .9539	10.7000± .0954	8.4000± .1431	77.5000± .4769	54.0000± .2384
quadriga	2	20.6000± .0751	11.8000± .0477	56.5000± .4769	10.9000± .0954	8.2000± .0477	75.0000± .7154	52.5000± .4769
apex[1]	1	19.25	11.50	59.50	10.30	8.10	78.50	52.50
fusca	2	20.6000± .3577	11.5000± .0954	55.5000± .4769	11.0000± .2384	8.2000± .0477	75.5000± .1923	53.0000± .2384
castanea[1]	1	21.05	11.30	53.50	10.70	8.30	78.50	50.50
Vaihiaiia, south, 1923, all	15	20.4100± .1438	11.5666± .0631	56.3667± .4445	10.7266± .0751	8.1800± .0536	76.1667± .4202	52.3000± .2559
Matapoopoo, west, 1923, zonata[1]	1	20.15	10.90	54.50	10.30	8.10	73.50	52.50
apex	2	20.9000± .0715	11.0000± .0477	52.5000± .0	10.9000± .0	7.5000± .0954	73.5000± .7154	51.5000± .0
Matapoopoo, west, 1923, all	3	20.6500± .1457	10.9666± .0367	53.1666± .3671	10.7000± .1101	7.8333± .1323	73.5000± .9539	51.8333± .1836
Matapoopoo middle, 1919, cingulata[1]	1	21.05	10.90	55.50	11.50	8.30	71.50	54.50
cestata	4	20.3750± .1049	11.3000± .0	55.2500± .3675	10.5500± .0997	8.1000± .0477	76.7500± .7681	51.5000± .8261
zonata	2	20.4500± .0	11.2000± .1431	55.0000± .7154	10.8000± .0477	8.0000± .0477	74.5000± .0	52.5000± .0
quadriga	5	21.2300± .1863	11.3400± .0800	53.3000± .6152	11.2600± .0451	8.1000± .1079	71.7000±1.0590	53.1000± .5394
apex[1]	1	21.05	11.70	54.50	10.90	8.30	74.50	51.50
Matapoopoo, middle, 1919, all	13	20.8192± .1126	11.3000± .0487	54.1154± .3560	10.9615± .0725	8.1154± .0474	73.9615± .6338	52.5000± .3741
Tepatu, 1923, cingulata	3	21.3500± .1652	10.9666± .0971	51.5000± .8412	10.9000± .0636	8.0333± .0734	73.1666± .9613	50.8333± .1836
cestata	3	20.0500± .1101	11.3000± .0	56.5000± .3179	10.5666± .0971	8.0333± .0367	76.8333± .3671	52.1666± .5027
zonata	3	21.1500± .2203	11.7666± .0367	55.1666± .2903	10.8333± .0367	8.2333± .0367	75.5000± .0	51.1666± .2903
quadriga	4	21.1250± .4765	10.8500± .2205	51.5000±1.2159	10.4000± .1390	7.5500± .1295	73.2500±1.1280	49 0000± .5592
apex	3	20.5500± .0550	11.8333± .1836	57.5000± .8412	11.0333± .1323	8.5666± .1046	77.5000± .3179	53.8333± .8002
Tepatu, 1923, all	16	20.8625± .1537	11.3125± .0964	54.2500± .5795	10.7000± .0631	8.0500± .0710	75.1250± .4456	51.2500± .3695
Pupuhi-Teviroa, 1923, cingulata	14	19.8286± .1284	11.2000± .0650	56.5000± .2549	10.6143± .0522	8.0272± .0483	75.5728± .3760	53.2857± .2377
apex	16	20.2062± .1280	11.1500± .0602	55.1875± .3023	10.6625± .0707	8.0125± .0653	75.0750± .3322	52 8750± .2973
Pupuhi-Teviroa, all	30	20.0300± .0937	11.1733± .0443	55.8000± .2170	10.6400± .0450	8 0200± .0415	75.3000± .2511	53.1666± .1990

[1] Class values.

TABLE 41—*Partula dendroica. Statistics of fecundity*

Series	Year	Records	Gravid	Per cent gravid	Eggs	Young	Total contents	Average for gravid	Average for all
Vaihiaiia, north	1924	15	11	73.3	15	16	31	2.82	2.06
Vaihiaiia, middle	1909	13	10	76.9	14	14	28	2.80	2.15
Vaihiaiia, south	1923	16	12	75.0	28	17	45	3.75	2.81
Matapoopoo, west	1923	6	4	66.6	8	3	11	2.75	1.83
Matapoopoo, middle	1919	11	9	81.8	15	13	28	3.11	2.54
Matapoopoo, south	1923	0	..	....	..	...	...	....	....
Tepatu	1923	27	25	92.6	45	44	89	3.56	3.29
Pupuhi-Teviroa	1923	32	25	78.1	52	27	79	3.16	2.47
All	.....	120	96	80.0	177	134	311	3.24	2.59

TABLE 42—*Partula dendroica. Recorded adults and their embryonic contents*

Number of eggs	Number of young					Totals	
	0	1	2	3	4		
0	24	1	2	..	..	27	
1	12	7	6	4	1	30	
2	9	11	18	4	2	44	177 eggs.
3	4	5	5	3	..	17	
4	1	..	..	1	..	2	
Totals	50	24	31	12	3	120 records.	
		134 young					

Summary	Embryonic contents							
	0	1	2	3	4	5	6	7
Number of adults—120	24	13	18	21	28	10	5	1

TABLE 43—*Partula dendroica. Heredity of coloration*

	Embryonic young															
	Vaihiaiia north		Vaihiaiia middle		Vaihiaiia south		Matapoopoo west		Matapoopoo middle		Tepatu		Pupuhi-Teviroa		Total	
	Banded	Plain	Banded	Plain	Banded	Plain	Banded	Plain	Banded	Plain	Banded	Plain	Banded	Plain	Banded	Plain
Adults:																
cingulata	14	...	5	1	6	1	...	...	1	1	9	...	7	7	42	10
cestata	...	...	...	...	...	...	...	...	...	2	...	...	...	...	...	2
zonata	...	...	...	...	...	...	...	...	1	...	4	15	...	...	5	15
quadriga	...	...	...	...	2	...	...	...	3	5	4	3	...	...	9	8
apex	2	...	...	...	2	6	...	3	...	...	8	1	6	7	18	17
fusca	...	...	4	4	...	...	...	...	...	...	...	...	...	...	4	4
castanea	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Total	16	...	9	5	10	7	...	3	5	8	25	19	13	14	78	56

Summary	Banded young	Plain young	Total
cingulata adults	56	35	91
All other adults	22	21	43
Total	78	56	134

TABLE 44—*Partula auraniia. Statistical description of dextral shells*

Series	No.	Shell			Aperture			Length aperture ÷length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
Range (class values)								
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Paraoro, middle, 1909	117	16.55 −19.55	8.7 −10.7	48.5 −60.5	8.3 −10.1	5.7 −7.3	66.5 −74.5	47.5 −54.5
Paraoro, middle, 1923	183	15.95 −19.85	8.7 −10.7	48.5 −59.5	7.7 − 9.9	5.3 −7.1	62.5 −75.5	46.5 −55.5
Paraoro, south, 1923	162	16.55 −20.45	9.3 −11.1	47.5 −59.5	8.3 −10.3	5.9 −7.1	62.5 −75.5	46.5 −54.5
Paparoa (Paopao), 1909	229	16.85 −20.75	9.3 −11.3	48.5 −61.5	8.5 −10.7	6.1 −7.7	67.5 −77.5	46.5 −55.5
Paparoa (Paopao), 1919	96	16.85 −20.45	9.5 −11.1	50.5 −59.5	8.7 −10.7	6.3 −7.7	67.5 −78.5	46.5 −55.5
Paparoa (Paopao), 1923	322	16.25 −21.05	9.3 −11.3	48.5 −59.5	8.3 −10.5	5.9 −7.7	64.5 −79.5	45.5 −55.5
Vaiare-Vaipohe, 1919	91	16.85 −20.15	9.3 −10.9	47.5 −61.5	8.7 −10.7	6.1 −7.7	67.5 −78.5	47.5 −57.5
Vaiare-Vaipohe, 1924	21	17.45 −19.85	9.7 −10.7	49.5 −56.5	8.9 −10.1	6.5 −7.5	69.5 −78.5	48.5 −53.5
Vaiare-Faamaariri, 1923	96	15.65 −20.15	8.5 −10.5	49.5 −59.5	7.7 −10.5	5.5 −7.1	65.5 −77.5	47.5 −58.5
Vaiare-Faamaariri, 1924	63	15.95 −19.25	8.7 −10.9	49.5 −56.5	8.3 − 9.9	5.5 −7.3	65.5 −77.5	46.5 −54.5
Whole series	1,380	15.65 −21.05	8.5 −11.3	47.5 −61.5	7.7 −10.7	5.3 −7.7	62.5 −79.5	45.5 −58.5
Mean value								
Paraoro, middle, 1909	117	18.1372± 0.0443	9.7325± 0.0229	53.5427± 0.1229	9.2710± 0.0238	6.4983±0.0189	69.9786± 0.1191	50.8931± 0.0988
Paraoro, middle, 1923	183	17.9517± .0367	9.7863± .0195	54.4126± .0992	9.0202± .0209	6.2650± .0152	69.2487± .1153	50.1504± .0809
Paraoro, south, 1923	162	18.4148± .0387	9.9481± .0186	53.9197± .0908	9.3234± .0194	6.4729± .0140	69.1976± .1250	50.5123± .0798
Paparoa, 1909	229	18.8544± .0344	10.2466± .0173	54.2904± .0926	9.6677± .0187	6.9594± .0146	71.9105± .0963	51.1375± .0773
Paparoa, 1919	96	18.7781± .0515	10.3208± .0229	54.9375± .1383	9.6938± .0268	7.0250± .0227	72.4584± .1536	51.5521± .1218
Paparoa, 1923	322	18.7431± .0306	10.1105± .0134	53.8633± .0759	9.4963± .0157	6.8923± .0116	72.5093± .0871	50.5652± .0699
Vaiare-Vaipohe, 1919	91	18.7060± .0520	10.1571± .0244	54.2253± .1504	9.5791± .0299	6.9242± .0234	72.2143± .1587	51.0933± .1305
Vaiare-Vaipohe, 1924	21	18.7643± .0909	10.1000± .0454	53.6905± .2594	9.6285± .0455	6.9762± .0400	72.9286± .3416	50.8333± .2048
Vaiare-Faamaariri, 1923	96	18.0812± .0551	9.7292± .0246	53.7500± .1516	9.2292± .0283	6.5666± .0201	70.9792± .1426	50.9479± .1236
Vaiare-Faamaariri, 1924	63	17.8643± .0575	9.5889± .0304	53.5317± .1444	8.9921± .0335	6.4778± .0290	71.9762± .2290	50.1984± .1425
Whole series	1,380	18.4809± .0152	10.0062± .0076	54.0594± .0367	9.4011± .0066	6.7155± .0077	71.2268± .0478	50.7442± .0320
Standard deviation								
Paraoro, middle, 1909	117	0.7115± 0.0313	0.3668± 0.0162	1.9716± 0.0869	0.3819± .0168	0.3032±0.0113	1.9108± 0.0842	1.5849± 0.0698
Paraoro, middle, 1923	183	.7356± .0259	.3914± .0138	1.9899± .0701	.4197± .0148	.3053± .0107	2.3123± .0815	1.6223± .0572
Paraoro, south, 1923	162	.7316± .0273	.3519± .0131	1.7132± .0642	.3661± .0137	.2643± .0099	2.3594± .0884	1.5071± .0564
Paparoa, 1909	229	.7723± .0243	.3671± .0122	2.0770± .0655	.4198± .0132	.3290± .0103	2.1610± .0681	1.7345± .0546
Paparoa, 1919	96	.7484± .0364	.3323± .0162	2.0094± .0978	.3889± .0188	.3003± .0160	2.2310± .1086	1.7699± .0861
Paparoa, 1923	322	.8144± .0216	.3570± .0095	2.0204± .0536	.4192± .0111	.3084± .0082	2.3185± .0616	1.8597± .0494
Vaiare-Vaipohe, 1919	91	.7361± .0367	.3549± .0172	2.1281± .1063	.4234± .0211	.3313± .1065	2.2448± .1122	1.8455± .0923
Vaiare-Vaipohe, 1924	21	.6174± .0643	.3086± .0321	1.7625± .1834	.3096± .0322	.2722± .0283	2.3211± .2415	1.3916± .1448
Vaiare-Faamaariri, 1923	96	.8013± .0389	.3582± .0174	2.2032± .1072	.4113± .0200	.2925± .0142	2.0715± .1008	1.7962± .0874
Vaiare-Faamaariri, 1924	63	.6770± .0416	.3577± .0215	1.6994± .1021	.3949± .0237	.3420± .0205	2.6954± .1619	1.6774± .1007
Whole series	1,380	.8387± .0107	.4213± .0053	2.0248± .0259	.3670± .0046	.4229± .0054	2.6328± .0338	1.7655± .0226

TABLE 45—*Partula aurantia. Statistical description of the color classes (dextral shells)*

Series	No.	Mean value						
		Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Paraoro, middle, 1909, fusca	67	18.1977 ±0.0491	9.6821 ±0.0273	53.0971 ±0.1465	9.2851 ±0.0279	6.4702 ±0.0226	69.5895 ±0.1505	50.7686 ±0.1278
lyra	46	18.0761 ± .0845	9.8043 ± .0403	54.1304 ± .2118	9.2522 ± .0435	6.5522 ± .0333	70.6304 ± .1907	51.0000 ± .1257
asymmetrica	2	18.2000 ± .0715	9.8000 ± .0477	53.5000 ± .0	9.2000 ± .1431	6.3000 ± .0954	69.0000 ± .2384	50.5000 ± .4769
zonata	2	17.4500 ± .2861	9.7000 ± .1908	55.0000 ± .2384	9.3000 ± .1908	6.4000 ± .1431	69.0000 ± .2384	53.0000 ± .2384
Paraoro, middle, 1909, all	117	18.1372 ± .0443	9.7325 ± .0229	53.5427 ± .1229	9.2710 ± .0238	6.4983 ± .0189	69.9786 ± .1191	50.8931 ± .0988
Paraoro, middle, 1923, fusca	130	17.9785 ± .0405	9.7984 ± .0227	54.4077 ± .1116	9.0431 ± .0239	6.2677 ± .0182	69.1846 ± .1428	50.2000 ± .0921
lyra	39	17.9808 ± .0789	9.8025 ± .0440	54.3975 ± .2369	8.9975 ± .0512	6.3000 ± .0332	69.5769 ± .2137	49.9872 ± .1939
asymmetrica	7	17.4929 ± .2288	9.5572 ± .1110	54.3572 ± .7005	8.8429 ± .0849	6.1000 ± .0770	68.7857 ± .5402	50.3572 ± .4400
zonata	6	17.9500 ± .1826	9.7666 ± .0687	54.3333 ± .4612	8.9666 ± .1038	6.2000 ± .0420	68.8333 ± .5877	49.6666 ± .4329
phæa	1	16.5500	9.3000	56.5000	8.5000	6.1000	70.5000	51.5000
Paraoro, middle, 1923, all	183	17.9517 ± .0307	9.7863 ± .0195	54.4126 ± .0992	9.0202 ± .0209	6.2650 ± .0152	69.2487 ± .1153	50.1504 ± .0809
Paraoro, south, 1923, fusca	102	18.3519 ± .0438	9.9470 ± .0236	54.0882 ± .1104	9.2806 ± .0238	6.4608 ± .0170	69.4216 ± .1541	50.4412 ± .1015
lyra	53	18.5311 ± .0788	9.9528 ± .0328	53.6321 ± .1679	9.4245 ± .0349	6.5037 ± .0263	68.8208 ± .2120	50.6509 ± .1410
zonata	7	18.4357 ± .1720	9.9285 ± .0743	53.6428 ± .3714	9.3285 ± .0635	6.4143 ± .0535	68.7857 ± .7912	50.5000 ± .2725
Paraoro, south, 1923, all	162	18.4148 ± .0357	9.9481 ± .0186	53.9197 ± .0908	9.3234 ± .0194	6.4729 ± .0140	69.1976 ± .1250	50.5123 ± .0798
Paparoa (Paopao), 1909, fusca	47	18.8096 ± .0738	10.2233 ± .0333	54.3936 ± .1928	9.7085 ± .0410	6.9681 ± .0304	71.6490 ± .1976	51.5000 ± .1591
lyra	121	18.8707 ± .0478	10.2488 ± .0228	54.2521 ± .1299	9.6537 ± .0252	6.9529 ± .0208	71.9546 ± .1408	50.9958 ± .0988
asymmetrica	57	18.8026 ± .0685	10.2684 ± .0339	54.4649 ± .1794	9.6579 ± .0397	6.9702 ± .0294	72.0965 ± .1914	51.2544 ± .1572
zonata	2	19.5500 ± .0	10.0000 ± .0477	51.5000 ± .4769	9.7000 ± .1908	6.8000 ± .0477	71.0000 ± .7154	49.5000 ± .9539
phæa	2	19.7000 ± .1526	10.3000 ± .0954	52.0000 ± .2384	9.8000 ± .0477	7.0000 ± .0477	71.0000 ± .2384	49.5000 ± .0
Paparoa (Paopao), 1909, all	229	18.8544 ± .0344	10.2466 ± .0173	54.2904 ± .0926	9.6677 ± .0187	6.9594 ± .0146	71.9105 ± .0963	51.1375 ± .0773

TABLE 45—*Partula aurantia. Statistical description of the color classes (dextral shells)*—Continued

Paparoa (Paopao), 1919, fusca	12	18.2250±0.0937	10.4000±0.0539	53.5833±0.2379	9.9333±0.0591	7.1000±0.0527	71.6666±0.3714	51.3333±0.3357
lyra	60	18.6800± .0667	10 3166± .0312	55.2666± .1722	9.6400± .0335	7.0200− .0281	72.8000± .2001	51.5555± .1479
asymmetrica	24	18.8000± .0409	10.2917± .0385	54.7916± .2906	9.7083± .0536	7.0000± .0337	72.0000± .2782	51.6666± .2938
Paparoa (Paopao), 1919, all	96	18.77[illegible]1± .0515	10.3[illegible]08± .02[illegible]9	54.9375± .1383	9.6938± .0268	7.0250± .0227	72.4584± .1536	51.5521± .1218
Paparoa (Paopao), 1923, fusca	5	19.2500± .1145	10.2200± .0724	52.9000± .6497	9.8600± .0703	7.0200± .0482	71.1000± .4514	51.3000± .2257
lyra	223	18.7482± .0356	10.1098± .0158	53.8318± .0953	9.4812± .0193	6.8928± .0138	72.6659± .1056	50.4507± .0881
asymmetrica	91	18.6928± .0626	10.0978± .0267	53.9725± .1259	9.5066± .0280	6.8758± .0220	72.1374± .1588	50.7967± .1174
zonata	3	19.0500± .2203	10.3666± .0734	54.5000± .3179	9.7000± .1101	7.3000± .1101	74.5000± .3179	50.8333± .1836
Paparoa (Paopao), 1923, all	322	18.7431± .0306	10.1105± .0134	53.8633± .0759	9.4963± .0157	6.8923± .0116	72.5093± .0871	50.5652± .0699
Vaiare-Vaipohe, 1919, fusca	3	18.3500± .2524	10.1000± .0636	55.5000± .6359	9.4333± .1836	6.9000± .0636	72.8333± .6619	51.1666± .1836
lyra	60	18.8050± .0670	10.1266± .0314	53.7666± .1920	9.5900± .0356	6.8934± .0305	71.8166± .1937	50.9166± .1707
asymmetrica	28	18.5322± .0787	10.2285± .0442	55.0714± .2085	9.5714± .0567	6.9928± .0370	73.0000± .2693	51.4643± .2057
Vaiare-Vaipohe, 1919, all	91	18.7060± .0520	10.1571± .0244	54.2253± .1504	9.5791± .0299	6.9242± .0234	72.2143± .1587	51.0933± .1305
Vaiare-Vaipohe, 1924, fusca	3	18.2500± .1101	10.1000± .0636	55.1666± .1836	9.6333± .0734	7.1000± .1101	72.8333± .2903	52.8333± .1836
lyra	10	18.6500± .0809	10.0400± .0506	53.7000± .3412	9.4600± .0597	6.9000± .0572	73.2000± .5315	50.3000± .2487
asymmetrica	8	19.1000± .1788	10.1750± .0952	53.1250± .4608	9.8375± .0589	7.0250± .0581	72.6250± .5648	50.7500± .2861
Vaiare-Vaipohe, 1924, all	21	18.7643± .0909	10.1000± .0454	53.6905± .2594	9.6285± .0455	6.9762± .0400	72.9286± .3416	50.8333± .2048
Vaiare-Faamaariri, 1923, fusca	38	17.9632± .0978	9.7105± .0398	53.9737± .2735	9.1263± .0449	6.5158± .0307	71.2632± .2360	50.7894± .1566
lyra	51	18.1676± .0703	9.7078± .0321	53.4020± .1844	9.2804± .0361	6.5823± .0275	70.7549± .1960	50.9117± .1927
asymmetrica	7	18.0928± .1382	9.9857± .0898	55.0714± .3568	9.4143± .1214	6.7285± .0743	71.0715± .3003	52.0714± .3003
Vaiare-Faamaariri, 1923, all	96	18.0812± .0551	9.7292± .0246	53.7500± .1516	9.2292± .0283	6.5666± .0201	70.9792± .1426	50.9479± .1236
Vaiare-Faamaariri, 1924, fusca	23	17.7239± .0979	9.5000± .0518	53.3696± .2665	8.9348± .0542	6.3522± .0471	70.8913± .4037	50.2391± .2695
lyra	32	17.8625± .0725	9.6063± .0421	53.7500± .1686	8.9687± .0454	6.5125± .0372	72.5937± .2849	50.1563± .1593
asymmetrica	8	18.2750± .1706	9.7750± .0581	53.1250± .4760	9.2500± .0916	6.7000± .0791	72.6250± .5520	50.2500± .5163
Vaiare-Faamaariri, 1924, all	63	17.8643± .0575	9.5[illegible]89± .0304	53.5317± .1444	8.9921± .0335	6.4778± .0290	71.9762± .2290	50.19[illegible]4± .1425
Whole series	1,380	18.4809± .0152	10.0062± .0076	54.0594± .0367	9.4011± .0066	6.7155± .0077	71.2268± .0478	50.7442± .0320

TABLE 46—*Partula aurantia. Statistical description of the color classes (dextral shells)*—Continued

Series	No.	Standard deviation						
		Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Paraoro, middle, 1909, fusca	67	0.5964±0.0347	0.3310±0.0193	1.7777±0.1036	0.3391±0.0197	0.2748±0.0160	1.8263±0.1064	1.5509±0.0903
lyra	46	.8504± .0597	.4059± .0285	2.1301± .1497	.4377± .0307	.3347± .0235	1.9180± .1348	1.2640± .0889
asymmetrica	2	.1500± .0505	.1000± .0337	0.0	.3000± .1012	.2000± .0674	0.5000± .1686	1.0000± .3372
zonata	2	.6000± .2023	.4000± .1349	0.5000± .1686	.4000± .1349	.3000± .1012	0.5000± .1686	0.5000± .1686
Paraoro, middle, 1909, all	117	.7115± .0313	.3668± .0162	1.9716± .0869	.3819± .0168	.3032± .0113	1.9108± .0842	1.5849± .0698
Paraoro, middle, 1923, fusca	130	.6842± .0286	.3843± .0160	1.8869± .0789	.4040± .0169	.3076± .0128	2.4148± .1010	1.5573± .0651
lyra	39	.7306± .0558	.4073± .0311	2.1932± .1675	.4747± .0362	.3072± .0234	1.9792± .1511	1.7956± .1371
asymmetrica	7	.8974± .1618	.4356± .0785	2.7479± .4953	.3332± .0600	.3023± .0544	2.1189± .3820	1.7261± .3111
zonata	6	.6633± .1291	.2494± .0486	1.6749± .3261	.3771± .0734	.1527± .0297	2.1344± .4155	1.5723± .3061
phæa	1	.....	.....	.....	.....	.....	.....	.....
Paraoro, middle, 1923, all	183	.7356± .0259	.3914± .0138	1.9899± .0701	.4197± .0148	.3053± .0107	2.3123± .0815	1.6223± .0572
Paraoro, south, 1923, fusca	102	.6568± .0310	.3544± .0167	1.6530± .0780	.3565± .0168	.2552± .0120	2.3081± .1089	1.5199± .0718
lyra	53	.8512± .0557	.3543± .0232	1.8123± .1187	.3771± .0247	.2841± .0186	2.2884± .1499	1.5221± .0997
zonata	7	.6749± .1216	.2914± .0525	1.4568± .2626	.2491± .0449	.2099± .0378	3.1037± .5594	1.0690± .1927
Paraoro, south, 1923, all	162	.7316± .0273	.3519± .0131	1.7132± .0642	.3661± .0137	.2643± .0099	2.3594± .0884	1.5071± .0564
Paparoa (Paopao), 1909, fusca	47	.7499± .0522	.3391± .0235	1.9595± .1363	.4166± .0290	.3093± .0215	2.0088± .1397	1.6177± .1125
lyra	121	.7798± .0338	.3722± .0161	2.1182± .0918	.4112± .0178	.3399± .0147	2.2962± .0995	1.6116± .0698
asymmetrica	57	.7668± .0484	.3798± .0240	2.0084± .1268	.4444± .0281	.3298± .0208	2.1428± .1353	1.7600± .1111
zonata	2	.0	.1000± .0337	1.0000± .3372	.4000± .1349	.1000± .0337	1.5000± .5058	2.0000± .6745
phæa	2	.3200± .1079	.2000± .0674	0.5000± .1686	.1000± .0337	.1000± .0337	0.5000± .1686	0.0
Paparoa (Paopao), 1909, all	229	.7723± .0243	.3671± .0122	2.0770± .0655	.4198± .0132	.3290± .0103	2.1610± .0681	1.7345± .0546

TABLE 46—*Partula aurantia. Statistical description of the color classes (dextral shells)*—Continued

Paparoa (Paopao), 1919, fusca	12	0.4815±0.0662	0.2769±0.0381	1.2219± .1682	0.3037±0.0418	0.2708±0.0372	1.9076±0.2626	1.7240±0.2374
lyra	60	.7663± .0471	.3583± .0220	1.9780± .1217	.3852± .0237	.3229± .0198	2.2971± .1415	1.6991± .1046
asymmetrica	24	.2975± .0289	.2798± .0272	2.1111± .2055	.3893± .0379	.2449± .0238	2.0207± .1967	2.1344± .2077
Paparoa (Paopao), 1919, all	96	.7484± .0364	.3323± .0162	2.0094± .0978	.3889± .0188	.3003± .0160	2.2310± .1086	1.7699± .0861
Paparoa (Paopao), 1923, fusca	5	.3795± .0809	.2400± .0512	2.1540± .4594	.2332± .0497	.1600± .0341	1.4966± .3192	0.7483± .1596
lyra	223	.7886± .0272	.3504± .0112	2.1107± .0674	.4288± .0136	.3053± .0097	2.3379± .0747	1.9506± .0623
asymmetrica	91	.8857± .0442	.3780± .0189	1.7811± .0890	.3961± .0198	.3121± .0155	2.2459± .1123	1.6608± .0830
zonata	3	.5657± .1558	.1886± .0519	0.8165± .2248	.2828± .0778	.2828± .0778	0.8165± .2248	0.4714± .1298
Paparoa (Paopao), 1923, all	322	.8144± .0216	.3570± .0095	2.0204± .0536	.4192± .0111	.3084± .0082	2.3185± .0616	1.8597± .0494
Vaiare-Vaipohe, 1919, fusca	3	.6481± .1785	.1633± .0450	1.6329± .4496	.4714± .1298	.1633± .0450	1.6997± .4680	0.4714± .1298
lyra	60	.7697± .0474	.3605± .0222	2.2054± .1357	.4093± .0252	.3502± .0215	2.2248± .1369	1.9604± .1207
asymmetrica	28	.6176± .0556	.3473± .0312	1.6357± .1474	.4447± .0401	.2902± .0261	2.1129± .1904	1.6143± .1454
Vaiare-Vaipohe, 1919, all	91	.7361± .0367	.3549± .0172	2.1281± .1063	.4234± .0211	.3313± .0165	2.2448± .1122	1.8455± .0923
Vaiare-Vaipohe, 1924, fusca	3	.2828± .0778	.1633± .0450	0.4714± .1298	.1886± .0519	.2828± .0778	0.7454± .2053	0.4714± .1298
lyra	10	.3795± .0572	.2375± .0358	1.6000± .2412	.2800± .0422	.2683± .0404	2.4920± .3758	1.1662± .1758
asymmetrica	8	.7500± .1264	.3992± .0673	1.9325± .3258	.2472± .0416	.2437± .0411	2.3684± .3994	1.1989± .2023
Vaiare-Vaipohe, 1924, all	21	.6174± .0643	.3086± .0321	1.7625± .1834	.3096± .0322	.2722± .0283	2.3211± .2415	1.3916± .1448
Vaiare-Faamaariri, 1923, fusca	38	.8941± .0691	.3640± .0281	2.4999± .1934	.4108± .0317	.2805± .0217	2.1574± .1669	1.4310± .1107
lyra	51	.7446± .0497	.3406± .0227	1.9529± .1304	.3825± .0255	.2915± .0194	2.0754± .1386	2.0405± .1362
asymmetrica	7	.5421± .0977	.3522± .0635	1.3997± .2523	.4764± .0858	.2914± .0525	1.1780± .2123	1.1780± .2123
Vaiare-Faamaariri, 1923, all	96	.8013± .0389	.3582± .0174	2.2032± .1072	.4113± .0200	.2925± .0142	2.0715± .1008	1.7962± .0874
Vaiare-Faamaariri, 1924, fusca	23	.6961± .0692	.3683± .0366	1.8952± .1884	.3852± .0383	.3348± .0333	2.8702± .2854	1.9160± .1905
lyra	32	.6081± .0512	.3535± .0297	1.4142± .1192	.3811± .0321	.3120± .0263	2.3896± .2014	1.3358± .1126
asymmetrica	8	.7155± .1206	.2437± .0411	1.9961± .3366	.3840± .0648	.3316± .0559	2.3150± .3903	2.1650± .3651
Vaiare-Faamaariri, 1924, all	63	.6770± .0416	.3577± .0215	1.6994± .1021	.3949± .0237	.3420± .0205	2.6954± .1619	1.6774± .1007
Whole series	1,380	.8387± .0107	.4213± .0053	2.0248± .0259	.3670± .0046	.4229± .0054	2.6328± .0338	1.7655± .0226

TABLE 47—*Partula aurantia. Progressive geographical and temporal differences of mean values, dextral shells*

Series	Shell			Aperture			Length aperture + length shell, proportions
	Length	Width	Proportions	Length	Width	Proportions	
	mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Paraoro middle, 1909..	−0.1855±0.0575	(+0.0538±0.0301)	+0.8699±0.1580	−0.2528±0.0317	−0.2333±0.0243	−0.7299±0.1672	−0.7427±0.1279
Paraoro, middle, 1923..	+ .4631± .0533	+ .1618± .0269	− .4929± .1345	+ .3032± .0285	+ .2079± .0207	(− .0511± .1700)	+ .3619± .1139
Paraoro, south, 1923..							
Paparoa, 1909.....	(− .0763± .0619)	(+ .0742± .0287)	+ .6471± .1664	(+ .0261± .0327)	(+ .0656± .0270)	+ .5479± .1809	(+ .4146± .1443)
Paparoa, 1919.....	(− .0350± .0599)	− .2103± .0265	−1.0742± .1577	+ .1975± .0311	− .1227± .0255	(+ .0409± .1761)	− .9869± .1404
Paparoa, 1923.....							
Paraoro, middle, 1909..	+ .7172± .0561	+ .5142± .0287	+ .7477± .1538	+ .3967± .0303	+ .4611± .0239	+1.9319± .1547	(+ .2444± .1254)
Paparoa, 1909.....							
Paraoro, south, 1923..	+ .3283± .0493	+ .1624± .0239	(− .0564± .1183)	+ .1729± .0249	+ .4194± .0182	+3.3117± .1523	(+ .0529± .1060)
Paparoa, 1923.....							
Paparoa, 1919.....	(− .0721± .0732)	− .1637± .0334	− .7152± .2043	(− .1147± .0401)	(− .1008± .0438)	(− .2441± .2205)	(− .4588± .1785)
Vaiare-Vaipohe, 1919..	(+ .0583± .1047)	(− .0571± .0515)	(− .5348± .2998)	(+ .0494± .0544)	(+ .0520± .0463)	(+ .7143± .3767)	(− .2600± .2412)
Vaiare-Vaipohe, 1924..							
Paraoro, south, 1923..	− .3336± .0673	− .2189± .0308	(− .1697± .1767)	(− .0942± .0343)	+ .0937± .0245	+ .7816± .1896	(+ .4356± .1471)
Vaiare-Faamaariri, 1923.....							
Vaiare-Faamaariri, 1924.....	(− .2169± .0796)	− .1403± .0391	(− .2183± .2094)	− .2371± .0439	(− .0888± .0353)	+ .9970± .2698	− .7495± .1886
Vaiare-Vaipohe, 1924 ..	− .9000± .1076	− .4111± .0546	(− .1585± .2969)	− .6364± .0565	− .4984± .0494	(− .9524± .4113)	(− .6349± .2479)
Vaiare-Faamaariri, 1924.....							

TABLE 48—*Partula aurantia. Statistics of tooth-development*

Series	Index					Total	Average
	1	2	3	4	5		
Paraoro, middle, 1909	105	58	2	..	..	165	1.3757
Paraoro, middle, 1923	154	61	..	..	..	215	1.2837
Paraoro, south, 1923	116	65	..	..	..	181	1.3591
Paparoa (Paopao), 1909	154	102	14	..	..	270	1.4852
Paparoa (Paopao), 1919	64	41	..	..	..	105	1.3905
Paparoa (Paopao), 1923	190	165	2	..	..	357	1.4734
Vaiare-Vaipohe, 1919	60	44	..	..	..	104	1.4230
Vaiare-Vaipohe, 1924	8	16	..	..	..	24	1.6666
Vaiare-Faamaariri, 1923	56	65	..	..	..	121	1.5372
Vaiare-Faamaariri, 1924	37	45	..	..	..	82	1.5487
Whole series	944	662	18	..	..	1624	1.4299

TABLE 49—*Partula aurantia. Statistics of fecundity*

Series	Records	Gravid	Per cent gravid	Eggs	Young	Total contents	Average for gravid	Average for all
Paraoro, middle, 1909	161	90	55.9	112	76	188	2.09	1.17
Paraoro, middle, 1923	203	174	85.7	333	219	552	3.17	2.72
Paraoro, south, 1923	180	118	65.5	224	106	330	2.79	1.83
Paparoa (Paopao), 1909	240	190	79.2	283	222	505	2.66	2.10
Paparoa (Paopao), 1919	102	90	88.2	149	99	248	2.75	2.43
Paparoa (Paopao), 1923	343	287	83.7	522	416	938	3.27	2.73
Vaiare-Vaipohe, 1919	96	87	90.6	137	95	232	2.67	2.42
Vaiare-Vaipohe, 1924	24	15	62.5	20	24	44	2.93	1.83
Vaiare-Faamaariri, 1923	97	78	80.4	184	129	313	4.01	3.23
Vaiare-Faamaariri, 1924	78	58	74.3	87	73	160	2.76	2.05
Whole series	1,524	1,187	77.9	2,051	1,459	3,510	2.96	2.30

TABLE 50—*Partula aurantia. Recorded adults and their embryonic contents*

Number of eggs	Number of young					Totals	
	0	1	2	3	4		
0	337	29	12	3	..	381	
1	158	123	108	12	1	402	
2	110	192	237	45	1	585	2,051
3	26	53	51	14	1	145	eggs
4	5	2	2	2	..	11	
Totals	636	399	410	76	3	1,524 records	
		1,459 young					

Summary	Embryonic contents							
	0	1	2	3	4	5	6	7
Number of adults: 1,524	337	187	245	329	307	99	17	3

TABLE 51—*Partula aurantia. Coloration of the embryonic young*

Parents	Paraoro		Paparoa		Vaiare-Vaipohe		Vaiare-Faamaariri		Total	
	plain	banded	plain	banded	plain	banded	plain	banded	plain	banded
fusca	254	2	65	....	8	....	82	....	409	2
lyra	116	....	453	18	61	....	104	1	734	19
asymmetrica	15	1	195	1	50	....	15	....	275	1
zonata	8	4	2	....	....	....	....	....	10	4
phæa	1	....	3	....	....	....	....	....	4	....
Total	394	7	718	19	119	....	201	1	1,432	27

TABLE 52—*Partula mirabilis. Summary statistical description (dextral shells)*

Series	No.	Shell			Aperture			Length aperture + length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
Range (class values)								
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Oio	1	16.55	8.7	53.5	8.3	5.7	68.5	50.5
Vaianai	73	14.75 –18.35	8.5 –10.3	51.5 –60.5	7.5 – 9.9	5.1 –6.7	61.5 –72.5	46.5 –58.5
Faataofe	485	14.15 –18.65	8.3 –10.3	53.5 –65.5	7.5 – 9.7	5.1 –6.7	63.5 –77.5	46.5 –59.5
Mouaroa	32	15.05 –18.05	8.7 –10.9	55.5 –61.5	7.7 – 9.9	5.5 –6.9	64.5 –72.5	50.5 –56.5
Maramu	573	15.05 –19.85	8.5 –11.1	51.5 –62.5	7.7 –10.5	5.3 –7.3	60.5 –78.5	47.5 –57.5
Tefeo	455	15.05 –18.95	8.3 –10.7	49.5 –64.5	7.5 – 9.9	5.3 –6.9	62.5 –76.5	46.5 –58.5
Tefeo east	769	14.75 –18.95	8.5 –11.1	51.5 –64.5	7.5 – 9.9	5.1 –6.9	63.5 –78.5	45.5 –57.5
Fareaito	401	14.75 –18.95	8.5 –10.9	51.5 –62.5	7.5 – 9.9	5.1 –6.9	64.5 –77.5	46.5 –55.5
Irua	494	14.45 –18.95	8.5 –10.5	51.5 –63.5	7.3 – 9.9	5.3 –6.7	61.5 –75.5	46.5 –57.5
Ririofau	22	15.05 –18.35	9.1 –10.5	53.5 –63.5	8.1 – 9.5	5.5 –7.1	65.5 –76.5	47.5 –54.5
Matapoopoo	884	14.15 –18.65	8.5 –10.7	52.5 –65.5	7.5 –10.1	5.3 –7.1	65.5 –79.5	47.5 –59.5
All[1]	4,189	14.15 –19.85	8.1 –11.1	49.5 –65.5	7.3 –10.5	5.1 –7.3	60.5 –79.5	45.5 –59.5
Mean value								
Vaianai	73	16.6198± 0.0578	9.4014± 0.0289	56.5000± 0.1443	8.7027± 0.0323	5.8945±0.0239	67.6233± 0.1857	52.2397± 0.1763
Faataofe	485	16.0013± .0212	9.3763± .0113	58.5289± .0604	8.4967± .0114	5.9932± .0091	70.3907± .0730	53.0072± .0560
Mouaroa	32	16.7750± .0759	9.7812± .0498	58.1563± .1899	8.8813± .0577	6.0750± .0420	68.2188± .2462	52.9062± .1974
Maramu	573	17.0657± .0216	9.7569± .0123	57.0148± .0584	8.8679± .0119	6.0704± .0091	68.2696± .0690	51.8508± .0471
Tefeo	455	16.7689± .0240	9.6745± .0127	57.6055± .0710	8.6855± .0132	6.0596± .0099	69.6275± .0777	51.6692± .0528
Tefeo east	769	16.6228± .0160	9.6418± .0089	57.9564± .0471	8.6329± .0092	6.0527± .0070	69.8875± .0545	51.8615± .0407
Fareaito	401	16.9425± .0234	9.7848± .0137	57.2332± .0634	8.6546± .0132	6.0995± .0102	70.4701± .0776	51.1035± .0540
Irua	494	16.4723± .0232	9.5895± .0083	58.1174± .0639	8.5967± .0135	5.8255± .0091	69.0688± .0707	52.0546± .0505
Ririofau	22	16.8500± .1077	9.8182± .0559	58.0000± .3237	8.8091± .0623	6.2091± .0473	70.2272± .3882	52.2273± .2417
Matapoopoo	884	16.5015± .0156	9.6265± .0085	58.2856± .0478	8.6783± .0082	6.1756± .0060	71.0215± .0518	52.5124± .0385
All[1]	4,189	16.6188± .0081	9.6249± .0042	57.8492± .0220	8.6668± .0042	6.0507± .0032	69.8208± .0262	52.0708± .0186
Standard deviation								
Vaianai	73	0.7324± 0.0408	0.3658± 0.0284	1.8282± 0.1020	0.4088± 0.0228	0.3033±0.0169	2.3522± 0.1313	2.2332± 0.1246
Faataofe	485	.6920± .0150	.3696± .0080	1.9728± .0427	.3720± .0081	.2966± .0064	2.3835± .0516	1.8294± .0396
Mouaroa	32	.6364± .0536	.4179± .0352	1.5931± .1336	.4844± .0408	.3527± .0297	2.0651± .1741	1.6556± .1396
Maramu	573	.7687± .0153	.4372± .0087	2.0716± .0413	.4233± .0084	.3230± .0064	2.4500± .0488	1.6723± .0333
Tefeo	455	.7586± .0169	.4005± .0090	2.2449± .0502	.4171± .0093	.3131± .0070	2.4578± .0549	1.6720± .0373
Tefeo east	769	.6637± .0114	.3672± .0063	1.9328± .0333	.3791± .0065	.2866± .0049	2.2412± .0385	1.6727± .0288
Fareaito	401	.6946± .0165	.4073± .0097	1.8834± .0448	.3925± .0093	.3024± .0072	2.3056± .0549	1.6042± .0382
Irua	494	.7639± .0164	.2752± .0058	2.1097± .0452	.4455± .0095	.3011± .0064	2.3323± .0500	1.6678± .0357
Ririofau	22	.7459± .0762	.3892± .0396	2.2512± .2289	.4337± .0441	.3288± .0335	2.6999± .2745	1.6807± .1708
Matapoopoo	884	.6904± .0110	.3733± .0060	2.1091± .0338	.3625± .0044	.2638± .0042	2.2852± .0366	1.6961± .0272
All[1]	4,189	.7762± .0057	.4068± .0029	2.1105± .0155	.4089± .0029	.3130± .0022	2.5148± .0185	1.7852± .0131

[1] Including the single shell from Oio Valley.

TABLE 53—*Partula mirabilis. Progressive comparison (dextral shells). Differences in mean values*

Series	Shell			Aperture			Length aperture + length shell, proportions
	Length	Width	Proportions	Length	Width	Proportions	
	mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Vaianai } Maramu	+0.4459±0.0617	+0.3555±0.0314	+0.5148±0.1557	+0.1652±0.0344	+0.1759±0.0256	+0.6463±0.1981	(−0.3889±0.1525)
Faataofe	+0.7737± .0788	+ .4049± .0511	(− .3726± .1993)	+ .3846± .0588	(+ .0818± .0430)	−2.1719± .2568	(− .1010± .2052
Mouaroa	+ .2907± .0816	(− .0243± .0513)	−1.1415± .1986	(− .0134± .0589)	(− .0046± .0430)	(+ .0508± .2557)	−1.0558± .2029
Maramu	− .2968± .0323	− .0824± .0177	+ .5907± .0919	− .1824± .0177	(− .0108± .0134)	+1.3579± .1039	(− .1816± .0708)
Tefeo	− .1461± .0289	(− .0327± .0155)	+ .3509± .0852	− .0526± .0161	(− .0069± .0121)	(+ .2600± .0949)	(+ .1923± .0667)
Tefeo east	+ .3197± .0283	+ .1430± .0163	− .7232± .0790	(+ .0217± .0160)	+ .0468± .0124	+ .5826± .0948	− .7580± .0676
Fareaito	− .4702± .0329	− .1953± .0160	+ .8842± .0900	− .0579± .0189	− .2740± .0137	−1.4013± .1050	+ .9511± .0739
Irua	+ .3777± .1102	+ .2287± .0574	(− .1174± .3299)	+ .2124± .0637	+ .3836± .0482	(+1.1584± .3946)	(+ .1727± .2489)
Ririofau							
Irua } Matapoopoo	(+ .0292± .0279)	(+ .0370± .0119	(+ .1682± .0798)	+ .0816± .0158	+ .3501± .0109	+1.9627± .0876	+ .4578± .0635

TABLE 54—*Partula mirabilis. Statistics of tooth-development*

Series	Year	No.	Index					Average
			1	2	3	4	5	
Oio	1919	1	...	1	...	...	...	2.0000
Vaianai	1923	74	...	46	25	2	1	1.4325
Faataofe, D	1923	140	9	113	15	2	1	1.9072
Faataofe, S	1923	3	...	2	1	...	...	2.3333
Faataofe, D	1924	396	28	300	64	3	1	2.1133
Faataofe, S	1924	7	1	5	1	...	...	2.0000
Mouaroa	1924	32	3	22	6	1	...	2.1562
Maramu, D	1909	323	3	281	37	2	...	2.1176
Maramu, S	1909	2	...	1	1	...	...	2.5000
Maramu	1919	38	1	17	14	5	1	2.6842
Maramu	1923	50	...	41	9	...	...	2.4500
Maramu	1924	214	4	166	40	3	1	2.2077
Tefeo	1923	478	3	389	78	7	1	2.1925
Tefeo east	1923	829	31	749	46	3	...	2.0253
Fareaito	1923	130	23	99	6	2	...	1.9000
Fareaito	1924	296	41	248	7	...	...	1.8852
Irua west	1919	56	8	46	...	2	...	1.8572
Irua east	1919	284	13	254	15	1	...	2.0211
Irua south	1923	236	3	219	14	...	...	2.0466
Ririofau	1924	23	2	20	1	...	...	2.0000
Matapoopoo	1909	69	12	56	1	...	...	1.8406
Matapoopoo	1919	215	45	165	5	...	...	1.8140
Matapoopoo west	1923	579	87	485	7	...	...	1.8618
Matapoopoo east	1923	131	27	102	1	...	...	1.8092
Summary:								
Outer series	....	75	...	47	25	1	1	2.4266
Inner series	....	3537	173	2972	355	32	5	2.0738
Rotui sector	....	994	171	808	15	...	...	1.8943
Whole series	....	4606	344	3827	395	34	6	2.0297

TABLE 55—*Partula mirabilis. Oio and Vaiana Valleys*

Mean value

Series	No.	Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Oio, 1919[1]	1	16.55	8.70	53.5	8.30	5.70	68.5	50.5
Vaianai, 1923, phæa	52	16.6134±0.0688	9.3769±0.0338	56.3654±0.1788	8.6692±0.0347	5.8639±0.0262	67.4423±0.2235	52.0577±0.2111
lyra	4	16.7750± .0438	9.3500± .0559	55.5000± .5332	8.7000± .0477	5.9000± .0674	67.2500± .4381	51.7500± .3675
mmata	17	16.6029± .1306	9.4882± .0649	57.1470± .2240	8.8059± .0863	6.0176± .0584	68.2657± .3786	52.9117± .3639
Vaianai, 1923, all	73	16.6198± .0578	9.4014± .0289	56.5000± .1443	8.7027± .0323	5.8945± .0239	67.6233± .1857	52.2397± .1763

Standard deviation

Vaianai, 1923, phæa	52	0.7356±0.0486	0.3619±0.0239	1.9118±0.1264	0.3708±0.0245	0.2805±0.0185	2.3892±0.1580	2.2567±0.1493
lyra	4	.1299± .0309	.1658± .0395	1.5811± .3770	.1414± .0337	.2000± .0476	1.2990± .3098	1.0897± .2598
mmata	17	.7986± .0923	.3968± .0459	1.3695± .1584	.5274± .0610	.3569± .0413	2.3144± .2677	2.2244± .2573
Vaianai, 1923, all	73	.7324± .0408	.3658± .0284	1.8282± .1020	.4088± .0228	.3033± .0169	2.3522± .1313	2.2332± .1246

[1] Class values.

TABLE 56—*Partula mirabilis. Faataofe and Mouaroa Valleys*

Series	No.	Shell: Length	Shell: Width	Shell: Proportions	Aperture: Length	Aperture: Width	Aperture: Proportions	Length aperture ÷ length shell, proportions
Mean value		*mm.*	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Faataofe, 1923, dex., apex	6	16.2500±0.1508	9.3000±0.0858	57.1666±0.2596	8.6666±0.0587	6.1666±0.0936	70.5000±0.6157	53.3333±0.3341
phæa	110	16.0400± .0512	9.3327± .0245	58.1636± .1278	8.5600± .0262	5.9209± .0201	69.2637± .1425	53.2000± .1081
lyra	7	15.7886± .1575	9.3857± .0461	59.6428± .5943	8.5571± .0849	5.9000± .0431	69.2143± .5024	54.2143± .6206
bisecta	6	15.5000± .1831	9.1000± .0858	59.0000± .4702	8.1666± .0688	5.7000± .0711	69.8333± .4944	52.3333± .2471
Faataofe, 1923, dex., all	129	16.0105± .0465	9.3232± .0220	58.2364± .1189	8.5465± .0238	5.9279± .0185	69.3295± .1308	53.2210± .1016
Faataofe, 1923, sin., phæa	3	16.4500± .4511	9.7000± .1909	59.5000± .6363	8.6333± .0735	6.3666± .0972	73.5000± .6363	52.8333± .9721
Faataofe, 1924, dex., apex	19	15.9342± .1059	9.4368± .0532	58.9210± .4088	8.3948± .0535	5.9947± .0475	71.1316± .3486	52.6052± .3019
mitella	11	16.3045± .1001	9.6818± .0659	59.1363± .4687	8.7000± .0520	6.2454± .0462	71.6818± .3540	53.4091± .3517
phæa	269	15.9837± .0271	9.3728± .0152	58.5595± .0768	8.4799± .0149	6.0033± .0117	70.6487± .0949	52.9721± .0760
lyra	49	15.9990± .0635	9.4469± .0356	58.9285± .1816	8.4714± .0323	6.0673± .0273	71.2755± .2196	52.8877± .1591
bisecta	8	16.1375± .1008	9.3500± .0944	58.0000± .5058	8.3750± .0952	5.9000± .0533	70.1250± .7440	51.8750± .4119
Faataofe, 1924, dex., all	356	15.9980± .0234	9.3955± .0131	58.6348± .0697	8.4787± .0128	6.0168± .0120	70.7809± .0831	52.9298± .0666
Faataofe, 1924, sin., phæa	6	16.2500± .2133	9.7000± .0954	59.3333± .7357	8.7000± .1034	6.2666± .0805	72.5000± .6535	53.5000± .5507
lyra [1]	1	15.65	9.90	62.50	8.50	6.30	74.50	53.50
Faataofe, 1924, sin., all	7	16.1643± .1905	9.7286± .0837	59.7857± .6910	8.6714± .0921	6.2714± .0691	72.7857± .5147	53.5000± .4720
Mouaroa, 1924, mitella	4	16.9250± .1942	10.0000± .1118	59.0000± .3770	8.9500± .1959	6.2500± .1295	68.5000± .2384	53.7500± .4381
phæa	27	16.7500± .0848	9.7593± .0551	58.1297± .2034	8.8852± .0611	6.0630± .0441	68.2037± .2888	52.8704± .2124
lyra [1]	1	16.85	9.50	55.50	8.50	5.70	67.50	50.50
Mouaroa, 1924, all	32	16.7750± .0759	9.7812± .0498	58.1563± .1899	8.8813± .0577	6.0750± .0420	68.2188± .2462	52.9062± .1974
Standard deviation								
Faataofe, 1923, dex., apex	6	0.5477±0.1066	0.3116±0.0606	0.9428±0.1835	0.2134±0.0415	0.3399±0.0662	2.2360±0.4353	1.2133±0.2362
phæa	110	.7963± .0362	.3809± .0173	1.9876± .0903	.4086± .0185	.3126± .0142	2.2154± .1007	1.6817± .0764
lyra	7	.6181± .1114	.1807± .0326	2.2315± .4202	.3332± .0600	.1069± .0305	1.9709± .3552	2.4328± .4388
bisecta	6	.6652± .1295	.3116± .0606	1.7078± .3325	.2494± .0486	.2582± .0503	1.7955± .3496	0.8976± .1747
Faataofe, 1923, dex., all	129	.7839± .0329	.3714± .0155	2.0020± .0841	.4012± .0168	.3118± .0131	2.2033± .0925	1.7117± .0718
Faataofe, 1923, sin., phæa	3	1.1576± .3190	.4899± .1350	1.6329± .4499	.1886± .0520	.2494± .0687	1.6329± .4499	2.4944± .6874
Faataofe, 1924, dex., apex	19	.6846± .0749	.3375± .0376	2.6421± .2891	.3394± .0378	.3069± .0335	2.2527± .2465	1.9512± .2258
mitella	11	.4924± .0708	.3342± .0466	2.3460± .3314	.2558± .0367	.2271± .0326	1.7487± .2503	1.7296± .2487
phæa	268	.6414± .0186	.3626± .0105	1.8553± .0540	.3560± .0103	.2646± .0077	2.3078± .0672	1.8516± .0539
lyra	49	.6593± .0449	.3696± .0252	1.8844± .1284	.3356± .0228	.2839± .0193	2.2791± .1553	1.6514± .1125
bisecta	8	.4226± .0713	.2958± .0667	2.1213± .3576	.3992± .0673	.2236± .0377	3.1200± .5261	1.7275± .2912
Faataofe, 1924, dex., all	355	.6411± .0162	.3644± .0092	1.9417± .0491	.3537± .0089	.2854± .0072	2.3263± .0589	1.8665± .0472
Faataofe, 1924, sin., phæa	6	.7746± .1508	.3464± .0674	2.6719± .5202	.3829± .0731	.2925± .0569	2.3805± .4621	2.0000± .3894
lyra	1	.....	.....	.....	.....	.....	.....	.....
Faataofe, 1924, sin., all	7	.7472± .1347	.3283± .0592	2.7106± .4886	.3614± .0651	.2711± .0488	2.0191± .3639	1.8517± .3337
Mouaroa, 1924, mitella	4	.5760± .1373	.3316± .0790	1.1180± .2666	.5810± .1385	.3840± .0916	0.7071± .1685	1.2990± .3098
phæa	27	.6532± .0599	.4245± .0389	1.5669± .1438	.4712± .0432	.3401± .0312	2.2247± .2042	1.6363± .1502
lyra	1	.....	.....	.....	.....	.....	.....	.....
Mouaroa, 1924, all	32	.6364± .0536	.4179± .0352	1.5931± .1336	.4844± .0408	.3527± .0297	2.0651± .1741	1.6556± .1396

[1] Class values.

TABLE 57—*Partula mirabilis. Maramu Valley*

Series	No.	Mean value						
		Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Maramu, 1909, dex., apex	117	17.3731±0.0442	10.0162±0.0231	57.4915±0.1114	8.9940±0.0262	6.2470±0.0182	69.3035±0.1481	51.6111±0.1001
mitella	23	17.3456± .1038	9.9869± .0585	57.5434± .2472	9.0217± .0630	6.1956± .0461	68.5435± .2829	51.8913± .1978
phæa	94	17.2585± .0542	9.9489± .0269	57.5425± .1361	8.9447± .0301	6.1830± .0218	68.9894± .1733	51.7234± .1045
lyra	6	17.2000± .2148	9.9000± .1005	57.3333± .3700	8.9000± .1589	6.0666± .1074	68.3333± .5823	51.6666± .3700
zonata	5	17.2100± .0886	10.0600± .1288	58.1000± .5594	9.0200± .0818	6.2600± .1040	68.5000± .8315	52.5000± .5047
subzonata	51	17.1618± .0853	9.8686± .0369	57.4020± .2159	8.8765± .0443	6.1157± .0272	68.9118± .2174	51.6372± .1576
Maramu, 1909, dex., all	296	17.2919± .0301	9.9655± .0152	57.5034± .0773	8.9588± .0173	6.1966± .0121	69.0439± .0937	51.6892± .0616
Maramu, 1909, sin., apex [1]	1	17.15	10.10	59.50	9.50	6.90	70.50	54.50
phæa [1]	1	17.45	10.70	60.50	9.70	6.90	72.50	54.50
Maramu, 1919, apex	13	17.3577± .1854	9.8230± .0756	56.8846± .4951	8.9615± .0694	6.2077± .0430	69.5000± .3362	51.5000± .3362
phæa	12	17.2750± .1249	9.6833± .0736	55.8333± .3584	8.8666± .0671	6.1166± .0561	68.8333± .3403	51.1666± .2152
zonata	4	17.0750± .1496	9.4500± .0299	55.5000± .6409	8.7500± .0559	6.0000± .0337	68.7500± .3675	51.5000± .4130
subzonata	8	17.3750± .1779	9.9750± .0751	57.7500± .4233	9.1500± .0705	6.3750± .0581	69.5000± .4299	52.7500± .4421
Maramu, 1919, all	37	17.3041± .0877	9.7703± .0429	56.5811± .2544	8.9486± .0390	6.1919± .0299	69.2027± .1944	51.6621± .1850
Maramu, 1923, apex	2	17.0000± .0715	9.4000± .0477	55.0000± .2384	9.0000± .0477	6.1000± .0	67.5000± .4769	52.5000± .0
phæa	20	16.6100± .0804	9.3800± .0606	56.2500± .3597	8.8100± .0499	5.9200± .0414	67.0500± .2545	52.8000± .1972
lyra	2	16.7000± .0715	9.2000± .1431	54.5000± .4769	8.7000± .0954	5.9000± .0954	67.0000± .7154	51.5000± .4769
zonata	23	17.1101± .0770	9.5087± .0480	56.3696± .2429	8.7174± .0524	5.9174± .0361	67.8043± .3003	51.5870± .2151
Maramu, 1923, all	47	16.7607± .0558	9.4362± .0363	56.2008± .2000	8.7681± .0342	5.9255± .0255	67.4787± .1898	52.1383± .1413
Maramu, 1924, apex	21	16.6929± .0766	9.5952± .0335	57.0714± .2857	8.6810± .0513	5.9000± .0272	67.4048± .3687	52.0238± .2633
mitella	8	17.2250± .1589	9.5000± .0584	55.0000± .5464	8.9000± .0859	5.8500± .0519	65.7500± .5811	51.5000± .4916
phæa	75	16.8460± .0537	9.5293± .0285	56.4333± .1582	8.7613± .0317	5.9026± .0224	67.0466± .1811	51.0466± .1319
lyra	2	17.3000± .3577	9.5000± .0954	55.5000± .4769	9.0000± .2384	6.1000± .0954	67.5000± .9538	52.5000± .4769
zonata	87	16.6879± .0485	9.4793± .0267	56.6954± .1355	8.7230± .0237	5.8724± .0183	67.2701± .1482	52.2126± .1373
Maramu, 1924, all	193	16.7885± .0328	9.5124± .0170	57.0018± .0968	8.7435± .0179	5.8886± .0126	67.1373± .1092	52.0647± .0882

[1] Class values.

TABLE 57—*Partula mirabilis. Maramu Valley*—Continued

Series	No.	Standard deviation						
		Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Maramu, 1909, dex., apex	117	0.7096±0.0312	0.3710±0.0163	1.7863±0.0788	0.4205±0.0185	0.2916±0.0128	2.3759±0.1047	1.6054±0.0708
mitella	23	.7381± .0734	.4163± .0413	1.7573± .1748	.4481± .0445	.3277± .0326	2.0104± .1999	1.4062± .1398
phæa	94	.7801± .0383	.3867± .0191	1.9565± .0962	.4328± .0213	.3134± .0154	2.4914± .1225	1.5025± .0739
lyra	6	.7801± .1519	.3651± .0710	1.3438± .2616	.5773± .1123	.3901± .0759	2.1148± .4117	1.3438± .2616
zonata	5	.2939± .0626	.4271± .0911	1.8547± .3955	.2713± .0578	.3447± .0735	2.7568± .5879	1.6733± .3569
subzonata	51	.9029± .0603	.3908± .0261	2.2859± .1526	.4696± .0313	.2879± .0192	2.3024± .1537	1.6689± .1114
Maramu, 1909, dex., all	296	.7695± .0213	.3880± .0107	1.9719± .0546	.4429± .0122	.3084± .0085	2.3904± .0662	1.5719± .0435
Maramu, 1919, apex	13	.9911± .1311	.4041± .0534	2.6469± .3501	.3712± .0491	.2302± .0304	1.7974± .2377	1.7974± .2377
phæa	12	.6418± .0883	.3782± .0520	1.8409± .2534	.3448± .0474	.2882± .0396	1.7480± .2406	1.1055± .1521
zonata	4	.4437± .1058	.0886± .0211	1.8708± .4532	.1658± .0395	.1000± .0238	1.0897± .2598	1.2247± .2920
subzonata	8	.7462± .1258	.3152± .0531	1.7853± .2993	.2958± .0498	.2437± .0411	1.8028± .3040	1.8540± .3126
Maramu, 1919, all	37	.7910± .0620	.3868± .0303	2.2943± .1799	.3523± .0276	.2695± .0211	1.7532± .1374	1.6687± .1308
Maramu, 1923, apex	2	.1500± .0506	.1000± .0337	0.5000± .1686	.1000± .0337	.0	1.0000± .3372	.0
phæa	20	.5333± .0568	.4019± .0428	2.3849± .2543	.3315± .0353	.2749± .0293	1.6875± .1799	1.3077± .1394
lyra	2	.1500± .0506	.3000± .1012	1.0000± .3372	.2000± .0674	.2000± .0674	1.5000± .5058	1.0000± .3372
zonata	23	.5479± .0544	.3412± .0339	1.7271± .1717	.3726± .0370	.2565± .0255	2.1353± .2123	1.5298± .1521
Maramu, 1923, all	47	.5669± .0394	.3693± .0256	2.0328± .1414	.3483± .0242	.2597± .0180	1.9295± .1342	1.4366± .0999
Maramu, 1924, apex	21	.5206± .0541	.2277± .0237	1.9413± .2020	.3486± .0363	.1852± .0192	2.5053± .2607	1.7891± .1862
mitella	8	.6666± .1123	.2449± .0413	2.2913± .3863	.3605± .0607	.2179± .0367	2.4367± .4109	2.0615± .3476
phæa	75	.6885± .0380	.3661± .0201	2.0286± .1118	.4066± .0224	.2875± .0158	2.3226± .1280	1.6915± .0932
lyra	2	.7500± .2529	.2000± .0674	1.0000± .3372	.5000± .1686	.2000± .0674	2.0000± .6744	1.0000± .3372
zonata	87	.6713± .0343	.3689± .0188	1.8747± .0958	.3286± .0167	.2540± .0129	2.0494± .1048	1.8989± .0971
Maramu, 1924, all	193	.6770± .0232	.3512± .0120	1.9941± .0684	.3695± .0126	.2609± .0089	2.2495± .0772	1.8174± .0623

TABLE 58—*Partula mirabilis. Tefeo and Tefeo East Valleys*

Series	No.	Mean value						
		Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Tefeo, 1923, lower, apex	4	17.4500±0.1339	9.6000±0.0754	55.2500±0.6901	8.8000±0.0754	6.0500±0.0734	68.2500±0.7681	50.7500±0.4976
mitella	2	17.3000± .2146	9.8000± .2384	57.0000± .7154	8.7000± .0954	6.2000± .0477	71.0000± .2384	50.0000± .2384
phæa	52	17.2596± .0730	9.7500± .0346	56.3846± .2113	8.9654± .0333	6.0962± .0242	67.8269± .2375	51.8269± .1708
lyra	2	17.0000± .0715	9.3000± .0	55.0000± .2384	8.5000± .0	5.8000± .0477	68.5000± .4769	50.5000± .0
zonata	7	17.4928± .0637	9.9857± .0770	56.9286± .2675	9.0143± .0662	6.1857± .0535	68.3572± .2523	51.5000± .3338
subzonata	33	17.2409± .0847	9.7303± .0392	56.2576± .2553	8.9485± .0444	6.1363± .0334	68.3485± .2128	51.7727± .1129
Tefeo, 1923, lower, all	100	17.2730± .0481	9.7460± .0244	56.3200± .1451	8.9410± .0242	6.1110± .0178	68.1300± .1504	51.6800± .1042
Tefeo, 1923, upper, apex	151	16.5083± .0415	9.5821± .0210	58.0099± .1220	8.5351± .0224	6.0166± .0173	70.3808± .1236	51.5794± .0874
mitella	14	16.5043± .0997	9.6857± .0687	58.3571± .3846	8.5714± .0571	6.0714± .0507	70.7143± .3350	51.5714± .3081
phæa	123	16.6671± .0381	9.6464± .0247	57.7032± .1248	8.6284± .0234	6.0106± .0203	69.4675± .1507	51.6545± .1137
lyra	15	16.9500± .1171	10.0200± .0489	58.9000± .3230	8.9533± .0678	6.3013± .0448	70.3000± .4281	52.8333± .3284
zonata	36	16.8833± .0757	9.8278± .0477	58.3055± .2440	8.7444± .0417	6.1555± .0346	70.2223± .2494	51.6944± .1713
subzonata	16	16.7375± .1349	9.6375± .0742	57.6250± .2520	8.6625± .0697	6.0625± .0495	70.1875± .3250	51.5000± .1885
Tefeo, 1923, upper, all	355	16.6303± .0144	9.6544± .0146	57.9676± .0763	8.6132± .0144	6.0454± .0116	70.0493± .0842	51.6662± .0610
Tefeo east, 1923, lower, apex	102	16.5353± .0452	9.6294± .0245	58.2061± .1246	8.5961± .0269	6.0471± .0193	70.1568± .1367	51.8621± .1018
mitella	2	16.4000± .0715	9.2000± .0477	56.0000± .7154	8.4000± .0477	5.6000± .0477	67.0000± .9538	51.0000± .2384
phæa	62	16.5210± .0613	9.6032± .0347	58.2581± .1876	8.6677± .0311	6.0768± .0244	69.8387± .1970	52.3709± .1371
lyra	27	16.4278± .0744	9.6630± .0447	58.6481± .2020	8.5963± .0396	6.0259± .0301	69.7592± .3112	52.1296± .2003
zonata	10	16.3400± .1833	9.6000± .0720	58.6000± .4716	8.5800± .1116	6.0600± .0805	70.4000± .3984	52.6000± .5263
subzonata	7	16.5500± .1081	9.5000± .0385	57.3572± .3455	8.5285± .0326	5.9572± .0230	69.3572± .3455	51.5000± .3047
Tefeo east, 1923, lower, all	210	16.5071± .0316	9.6162± .0173	58.2476± .0911	8.6124± .0177	6.0438± .0132	69.9714± .1012	52.0619± .0758
Tefeo east, 1923, upper, apex	199	16.7188± .0316	9.6457± .0169	57.6457± .0917	8.6538± .0178	6.0628± .0137	69.8819± .1059	51.7261± .0777
mitella	126	16.5976± .0481	9.6524± .0219	58.1793± .1159	8.6174± .0232	6.0312± .0170	69.9047± .1316	51.8016± .1058
phæa	85	16.7053± .0466	9.6553± .0264	57.7706± .1146	8.6082± .0281	6.0553± .0218	69.8764± .1610	51.5235± .1052
lyra	111	16.6121± .0453	9.6640± .0257	58.1036± .1324	8.6748± .0243	6.0748± .0185	69.8153± .1619	52.1571± .1109
zonata	23	16.6413± .0883	9.6478± .0471	57.8043± .2637	8.6391± .0507	6.0391± .0356	69.7609± .2461	51.8048± .2211
subzonata	15	16.7700± .0963	9.6067± .0537	57.1666± .2517	8.5933± .0581	5.9800± .0418	69.4333± .4288	51.1666± .3852
Tefeo east, 1923, upper, all	559	16.6664± .0186	9.6514± .0104	57.8475± .0545	8.6406± .0108	6.0560± .0082	69.8560± .0646	51.7862± .0480
Tefeo, 1923, all	455	16.7689± .0240	9.6745± .0127	57.6055± .0710	8.6855± .0132	6.0596± .0099	69.6275± .0777	51.6692± .0528
Tefeo east, 1923, all	769	16.6228± .0161	9.6418± .0089	57.9564± .0471	8.6329± .0092	6.0527± .0070	69.8875± .0545	51.8615± .0407

TABLE 58—*Partula mirabilis. Tefeo and Tefeo East Valleys*—Continued

Standard deviation

Series	No.	Shell			Aperture			Length aperture + length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Tefeo, 1923, lower, apex	4	0.3674±0.0983	0.2236±0.0533	2.0463±0.4879	0.2236±0.0533	0.2179±0.0519	2.2776±0.5431	1.4756±0.3518
mitella	2	.4500± .1517	.5000± .1686	1.5000± .5058	.2000± .0674	.1000± .0337	0.5000± .1686	0.5000± .1686
phæa	52	.7806± .0516	.3698± .0244	2.2588± .1494	.3567± .0235	.2586± .0171	2.5398± .1679	1.8263± .1208
lyra	2	.1500± .0505	.0	0.5000± .1686	.0	.1000± .0337	1.0000± .3372	.0
zonata	7	.2499± .0450	.3020± .0544	1.0494± .1891	.2997± .0468	.2099± .0378	0.9897± .1784	1.3093± .2360
subzonata	33	.7217± .0599	.3344± .0277	2.1746± .1805	.3783± .0314	.2848± .0236	1.8127± .1505	0.9621± .0798
Tefeo, 1923, lower, all	100	.7138± .0340	.3620± .0172	2.1512± .1026	.3592± .0171	.2644± .0126	2.2300± .1063	1.5452± .0737
Tefeo, 1923, upper, apex	151	.7557± .0293	.3831± .0148	2.2223± .0862	.4075± .0158	.3151± .0122	2.2521± .0874	1.5927± .0618
mitella	14	.5536± .0704	.3814± .0486	2.1333± .2719	.3172± .0404	.2814± .0358	1.8585± .2368	1.7098± .2178
phæa	123	.6270± .0`69	.4065± .0174	2.0520± .0882	.3852± .0165	.3337± .0143	2.4789± .1065	1.8699± .0804
lyra	15	.6723± .0828	.2809± .0346	1.8547± .2284	.3897± .0479	.2572± .0317	2.4583± .3027	1.8856± .2322
zonata	36	.6737± .0535	.4247± .0316	2.1708± .1725	.3715± .0295	.3077± .0244	2.2188± .1763	1.5242± .1211
subzonata	16	.7999± .0954	.4399± .0524	1.4948± .1782	.4136± .0493	.2934± .0350	1.9274± .2298	1.1180± .1333
Tefeo, 1923, upper, all	355	.7099± .0172	.4084± .0103	2.1325± .0539	.4035± .0102	.3240± .0082	2.3520± .0595	1.7059± .0431
Tefeo east, 1923, lower, apex	102	.6765± .0320	.3670± .0173	1.8659± .0881	.4026± .0190	.2896± .0136	2.0463± .0967	1.5250± .0720
mitella	2	.1500± .0505	.1000± .0337	1.5000± .5055	.1000± .0337	.1000± .0337	2.0000± .6744	0.5000± .1686
phæa	62	.7163± .0440	.4059± .0245	2.1900± .1326	.3631± .0220	.2855± .0172	2.2997± .1393	1.6013± .0969
lyra	27	.5731± .0526	.3444± .0316	1.5564± .1428	.3049± .0280	.2319± .0213	2.3974± .2200	1.5432± .1416
zonata	10	.8596± .1296	.3376± .0509	2.2113± .3334	.5231± .0789	.3774± .0569	1.8681± .2817	2.4678± .3721
subzonata	7	.4242± .0764	.1512± .0272	1.3554± .2443	.1278± .0230	.0904± .0162	1.5518± .2797	1.1952± .2154
Tefeo east, 1923, lower, all	210	.6783± .0223	.3716± .0122	1.9586± .0644	.3809± .0125	.2850± .0093	2.1738± .0715	1.6296± .0536
Tefeo east, 1923, upper, apex	199	.6620± .0223	.3528± .0119	1.9189± .0648	.3722± .0126	.2878± .0097	2.2157± .0749	1.6239± .0471
mitella	126	.6005± .0341	.3647± .0155	1.9290± .0819	.3865± .0164	.2829± .0120	2.1901± .0930	1.7605± .0748
phæa	85	.6370± .0329	.3609± .0186	1.5672± .0810	.3839± .0198	.2980± .0154	2.2015± .1138	1.4388± .0744
lyra	111	.7080± .0320	.4011± .0182	2.0677± .0936	.3797± .0172	.2893± .0131	2.5290± .1149	1.7320± .0784
zonata	23	.6282± .0624	.3348± .0333	1.8751± .0864	.3609± .0358	.2532± .0252	1.7500± .1740	1.5723± .1563
subzonata	15	.5528± .0681	.3087± .0380	1.4453± .1780	.3336± .0411	.2400± .0295	2.4621± .3032	2.2118± .2724
Tefeo east, 1923, upper, all	559	.6528± .0131	.3651± .0073	1.9115± .0383	.3782± .0076	.2871± .0058	2.2651± .0457	1.6824± .0339
Tefeo, 1923, all	455	.7586± .0169	.4005± .0090	2.2449± .0502	.4171± .0093	.3131± .0070	2.4578± .0549	1.6720± .0373
Tefeo east, 1923, all	769	.6637± .0114	.3672± .0063	1.9328± .0333	.3791± .0065	.2866± .0049	2.2412± .0385	1.6727± .0288

TABLE 59—*Partula mirabilis Fareaito Valley*

Series	No.	Shell			Aperture			Length aperture + length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
Mean value								
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Fareaito, 1923, apex [1]	1	16.25	9.50	58.5	8.10	5.70	70.5	49.5
mitella	28	17.1071 ±0.0796	9.9357 ±0.0457	57.8214 ±0.2261	8.8643 ±0.0505	6.2714 ±0.0338	70.7857 ±0.2785	51.6785 ±0.2286
phæa	17	16.9735 ± .1409	9.6765 ± .0792	57.0294 ± .3180	8.6412 ± .0734	6.1117 ± .0658	70.2953 ± .4815	50.6765 ± .2818
lyra	58	16.9431 ± .0666	9.6655 ± .0348	57.0517 ± .1726	8.6483 ± .0306	6.0724 ± .0240	69.9655 ± .1757	51.1035 ± .1252
zonata	18	16.9833 ± .0930	9.7555 ± .0538	57.2223 ± .3547	8.7000 ± .0474	6.1333 ± .0427	69.8333 ± .3475	51.5555 ± .2278
Fareaito, 1923, all	132	16.9852 ± .0441	9.7410 ± .0248	57.2623 ± .1206	8.7000 ± .0232	6.1395 ± .0185	70.1803 ± .1366	51.2295 ± .0973
Fareaito, 1924, apex	7	16.8928 ± .1755	9.7857 ± .1257	57.6428 ± .4184	8.6428 ± .0525	6.1573 ± .0355	70.6428 ± .3956	51.2143 ± .3257
mitella	49	17.1561 ± .0710	9.7939 ± .0410	57.0306 ± .1858	8.7571 ± .0395	6.1326 ± .0295	69.6429 ± .2041	51.0305 ± .1698
phæa	10	16.7300 ± .1436	9.8000 ± .0837	58.0000 ± .3199	8.6200 ± .0995	6.1800 ± .0666	71.5000 ± .6608	50.9000 ± .4179
lyra	187	16.8452 ± .0331	9.6444 ± .0202	57.1738 ± .0894	8.5856 ± .0193	6.0551 ± .0148	70.2915 ± .1150	50.9171 ± .0799
zonata	24	17.0750 ± .0784	9.8166 ± .0573	57.2500 ± .2583	8.7583 ± .0460	6.1750 ± .0401	70.0834 ± .3932	51.2916 ± .2350
subzonata	2	17.1500 ± .1431	9.6000 ± .0477	55.0000 ± .4769	8.8000 ± .1431	6.1000 ± .0954	70.0000 ± .2384	51.0000 ±1.1923
Fareaito, 1924, all	279	16.9274 ± .0276	9.6943 ± .0169	57.1846 ± .0741	8.6347 ± .0160	6.0964 ± .0121	70.2097 ± .0932	50.9767 ± .0675
Standard deviation								
Fareaito, 1923, apex	1	.....	.....	.....	.....	.....	.....	.....
mitella	28	0.6247 ±0.0563	0.3589 ±0.0323	1.7739 ±0.1599	0.3966 ±0.0357	0.2657 ±0.0239	2.1853 ±0.1969	1.7939 ±0.1616
phæa	17	.8613 ± .0996	.4845 ± .0560	1.9438 ± .2248	.4486 ± .0519	.4024 ± .0465	2.9435 ± .3405	1.7230 ± .1992
lyra	58	.7519 ± .0471	.3933 ± .0246	1.9491 ± .1220	.3455 ± .0216	.2715 ± .0170	1.9845 ± .1242	1.4135 ± .0885
zonata	18	.5850 ± .0657	.3387 ± .0380	2.2312 ± .2508	.2981 ± .0335	.2687 ± .0302	2.1858 ± .2457	1.4328 ± .1611
Fareaito, 1923, all	132	.7218 ± .0312	.4064 ± .0175	1.9755 ± .0853	.3807 ± .0164	.3026 ± .0131	2.2370 ± .0966	1.5942 ± .0688
Fareaito, 1924, apex	7	.6883 ± .1241	.4933 ± .0889	1.6413 ± .2958	.2060 ± .0371	.1395 ± .0251	1.5518 ± .2797	1.2778 ± .2303
mitella	49	.7372 ± .0502	.4259 ± .0290	1.9283 ± .1314	.4101 ± .0279	.3059 ± .0208	2.1189 ± .1443	1.7625 ± .1200
phæa	10	.6735 ± .1015	.3924 ± .0592	1.5000 ± .2262	.4665 ± .0703	.3124 ± .0471	3.0983 ± .4672	1.9595 ± .2955
lyra	187	.6722 ± .0234	.4089 ± .0143	1.8136 ± .0632	.3907 ± .0136	.2999 ± .0104	2.3319 ± .0813	1.6212 ± .0565
zonata	24	.5695 ± .0554	.4160 ± .0405	1.8764 ± .1826	.3341 ± .0325	.2916 ± .0283	2.8563 ± .2780	1.7073 ± .1662
subzonata	2	.3000 ± .1012	.1000 ± .0337	1.0000 ± .3372	.3000 ± .1012	.2000 ± .0674	0.5000 ± .1686	2.5000 ± .8431
Fareaito, 1924, all	279	.6838 ± .0195	.4192 ± .0119	1.8358 ± .0524	.3959 ± .0113	.3009 ± .0085	2.3074 ± .0659	1.6716 ± .0477

[1] Class values.

TABLE 60—*Partula mirabilis. Irua and Ririofau Valleys*

Series	No.	Mean value						
		Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Irua west, 1919, apex[1]	1	16.85	10.10	60.5	9.10	6.30	70.5	51.5
mitella	5	16.7900±0.1390	9.5400±0.0591	56.9000±0.2413	8.6200±0.0980	5.9400±0.0703	69.1000±0.4091	50.7000±0.2955
phæa	12	16.9000± .1829	9.6000± .0665	56.7500± .3739	8.6500± .0928	5.9266± .0701	68.5000± .6650	51.0000± .3419
lyra	24	16.9125± .1073	9.5917± .0578	56.7500± .3085	8.7166± .0630	6.0000± .0442	68.7083± .4600	51.8750± .2311
zonata	5	17.1500± .1145	9.6200± .0482	56.1000± .3619	8.9800± .0615	6.2600± .0241	69.7000± .6441	51.7000± .2257
Irua west, 1919, all	47	16.9564± .0751	9.6021± .0358	56.6489± .1967	8.7266± .0432	6.0064± .0316	68.8404± .2957	51.5000± .1585
Irua east, 1919, apex	60	16.4800± .0613	9.9044± .0334	58.1666± .1739	8.6766± .0354	6.0166± .0258	69.2500± .1844	52.5000± .1151
mitella	29	16.4990± .0648	9.7414± .0300	57.6310± .2844	8.7207± .0297	6.0931± .0311	69.6034± .2190	52.7758± .1798
phæa	55	16.3264± .0561	9.7545± .0211	58.1182± .1756	8.5727± .0366	5.9582± .0277	69.3546± .2098	52.2455± .1312
lyra	73	16.4514± .0680	9.5493± .0311	58.0342± .1929	8.6041± .0348	5.9822± .0238	69.4726± .1911	52 1849± .1239
zonata	24	16.4750± .0853	9.5583± .0576	57.8750± .2833	8.6834± .0620	5.9750± .0404	68.6666± .2801	52.4166± .2314
subzonata	18	16.8166± .1167	9.6555± .0525	57.3889± .3780	8.7111± .0455	6.0223± .0262	68.6112± .3039	51.8333± .2804
Irua east, 1919, all	259	16.4643± .0302	9.5880± .0155	58.1100± .0905	8.6421± .0168	5.9996± .0121	69.2761± .0927	52.3456± .0636
Irua south, 1923, apex	66	16.3227± .0667	9.4727± .0362	57.9697± .1417	8.4152± .0400	5.8182± .0247	68.8939± .1466	51.3485± .1342
mitella	50	16.4180± .0487	9.6440± .0376	58.7400± .1701	8.5600± .0397	5.8640± .0240	68.3000± .2313	52.1000± .1695
phæa	14	16.4427± .1729	9.7000± .0982	58.6428± .3723	8.5857± .0921	5.9428± .0627	69.1428± .2776	52 0714± .2701
lyra	57	16.3553± .0661	9.6544± .0386	58.8684± .1799	8.5421± .0462	5.9035± .0306	69.0965± .2360	51.9912± .1756
zonata[1]	1	16.46	9.10	57.50	7.90	5.90	73.5	50.5
Irua south, 1923, all	188	16.3633± .0351	9.5883± .0217	58.4947± .0931	8.5021± .0238	5.8660± .0151	68.8404± .1118	51.7925± .0882
Ririmfau, 1924, apex	3	15.5500± .1446	9.4333± .0367	60.5000± .8340	8.1666± .0368	6.1000± .0627	73.8333± .3671	52.8333± .4857
mitella	11	16.9100± .1252	9.8800± .0774	58.3000± .3282	8.8200± .0823	6.2600± .0840	70.5000± .6134	52.2000± .3024
phæa	4	17.0000± .1143	9.8500± .1536	57.2500± .6476	9.0000± .1012	6.1000± .1261	67.7500± .4981	52.5000± .4130
lyra	5	17.3900± .1557	9.9000± .1079	56.5000± .6875	9.0200± .1119	6.2600± .0703	69.5000± .1907	51.7000± .7239
Ririofau, 1924, all	22	16.8500± .1077	9.8182± .0559	58.0000± .3237	8.8091± .0623	6.2091± .0473	70.2272± .3882	52.2273± .2417

[1] Class values.

TABLE 60—*Partula mirabilis. Irua and Ririofau Valleys*—Continued

Standard deviation								
Irua west, 1919, apex	1							
mitella	5	0.4609± .0982	0.1959±0.0418	0.8000±0.1706	0.3249±0.0693	0.2332±0.0497	1.3564±0.2893	0.9798±0.2089
phæa	12	.9394± .1293	.3415± .0470	1.9203± .2644	.4769± .0656	.3603± .0495	3.4155± .4702	1.7559± .2417
lyra	24	.7792± .0759	.4202± .0409	2.2407± .2181	.4579± .0445	.3214± .0312	3.3414± .3252	1.6786± .1634
zonata	5	.3795± .0809	.1600± .0341	1.2000± .2559	.2039± .0435	.0800± .0170	2.1354± .4554	0.7483± .1596
Irua west, 1919, all	47	.7631± .0531	.3640± .0253	1.9998± .1391	.4397± .0305	.3218± .0223	3.0055± .2091	1.6111± .1121
Irua east, 1919, apex	60	.7043± .0433	.3833± .0236	1.9972± .1229	.4068± .0250	.2950± .0182	2.1184± .1304	1.3219± .0814
mitella	29	.5171± .0458	.2399± .0212	2.2705± .2011	.2370± .0210	.2490± .0220	1.7488± .1548	1.4359± .1200
phæa	55	.6167± .0396	.2319± .0149	1.9305± .1241	.4024± .0259	.3043± .0196	2.3074± .1483	1.4425± .0928
lyra	73	.8616± .0481	.3942± .0220	2.4444± .1364	.4405± .0246	.3013± .0168	2.4212± .1351	1.5692± .0876
zonata	24	.6199± .0603	.4182± .0407	2.0578± .2003	.4506± .0438	.2933± .0285	2.0344± .1980	1.6812± .1636
subzonata	18	.7341± .0825	.3304± .0371	2.3779± .2673	.2865± .0322	.1652± .0185	1.9117± .2149	1.7638± .1983
Irua east, 1919, all	259	.7216± .0213	.3715± .0109	2.1611± .0640	.4014± .0119	.2895± .0085	2.2118± .0655	1.5192± .0450
Irua south, 1923, apex	66	.8033± .0471	.4361± .0256	1.7075± .1002	.4825± .0283	.2974± .0174	1.7657± .1036	1.6166± .0949
mitella	50	.7103± .0344	.3940± .0266	1.7839± .1203	.4162± .0281	.2520± .0170	2.4249± .1635	1.7776± .1198
phæa	14	.9595± .1222	.5451± .0694	2.0652± .2632	.5111± .0651	.3479± .0443	1.5403± .1963	1.4983± .1910
lyra	57	.7402± .0467	.4321± .0273	2.0142± .1272	.5178± .0326	.3423± .0216	2.6415± .1669	1.9657± .1241
zonata	1							
Irua south, 1923, all	188	.7749± .0269	.4425± .0153	1.8920± .0658	.4852± .0168	.3068± .0107	2.2741± .0790	1.7938± .0623
Ririofau, 1929, apex	3	.3741± .1022	.0943± .0259	2.1602± .5897	.0945± .0260	.1633± .0443	0.9428± .2596	1.2472± .3434
mitella	11	.5817± .0885	.3628± .0547	1.5362± .2321	.3816± .0582	.3666± .0595	2.8284± .4337	1.4177± .2138
phæa	4	.3391± .0808	.4555± .1086	1.9203± .4579	.3000± .0715	.3741± .0891	1.4769± .3522	1.2247± .2920
lyra	5	.5161± .1101	.3578± .0763	2.2803± .4863	.3709± .0791	.2332± .0497	0.6324± .1348	2.4000± .5119
Ririofau, 1924, all	22	.7459± .0761	.3892± .0396	2.2512± .2289	.4337± .0441	.3288± .0335	2.6999± .2745	1.6807± .1708

TABLE 61—*Partula mirabilis. Matapoopoo Valley*

Series	No.	Shell			Aperture			Length aperture + length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
Mean value		*mm.*	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct*	*p. ct.*
Matapoopoo, 1909, apex	3	16.8500±0.1129	9.5666±0.0367	57.1666±0.9713	8.6344±0.0734	6.1666±0.0367	71.1666±0.4857	51.5000±0.3179
lyra	55	16.3755± .0716	9.4891± .0322	57.8272± .1717	8.6746± .0320	6.1182± .0200	70.3364± .2136	52.9182± .1605
zonata	2	16.8500± .4292	9.4000± .0477	56.0000±1.1923	8.7000± .0954	6.0000± .0477	69.0000± .2384	51.5000± .4769
Matapoopoo, 1909, all	60	16.4150± .0688	9.4900± .0297	57.2666± .1722	8.6734± .0297	6.1166± .0186	70.3333± .1993	52.2000± .1527
Matapoopoo, 1919, apex	8	16.1750± .1173	9.6000± .0413	59.2500± .5299	8.5000± .0533	6.2000± .0238	73.0000± .5718	52.1250± .2905
lyra	177	16.3059± .0394	9.5056± .0176	58.3136± .1040	8.5542± .0187	6.0366± .0131	70.3871± .1058	52.4040± .0860
zonata	4	16.6250± .1813	9.5000± .0477	57.2500± .4381	8.5500± .0876	6.2000± .0337	72.2500± .5529	51.7500± .7301
Matapoopoo, 1919, all	189	16.3072± .0375	9.5095± .0166	58.3307± .1011	8.5518± .0178	6.0471± .0125	70.5370± .1066	52.3783± .0911
Matapoopoo west, 1923, apex	33	16.6500± .0686	9.6394± .0394	57.8030± .2191	8.8151± .0409	6.1970± .0295	70.0758± .2401	52.9242± .1557
phæa	5	17.1500± .1982	9.7400± .0591	56.7000± .6152	8.9000± .0660	6.2600± .0241	70.5000± .3815	51.9000± .3076
lyra	456	16.5132± .0205	9.6162± .0115	58.1579± .0666	8.6952± .0112	6.1965± .0078	71.0877± .0696	52.5438± .0526
zonata	13	16.7807± .0938	9.8075± .0650	58.1923± .4365	8.8538± .0706	6.3461± .0444	71.5769± .3401	52.7307± .3211
subzonata	13	16.4577± .1088	9.4231± .0648	57.2693± .3126	8.6539± .0706	6.0539± .0467	70.2693± .3679	52.1925± .2970
Matapoopoo west, 1923, all	520	16.5333± .0191	9.6188± .0107	58.1000± .0621	8.7077± .0106	6.1973± .0073	71.0096± .0642	52.5577± .0487
Matapoopoo east, 1923, apex	18	16.8266± .0848	9.8333± .0551	58.6112± .2945	8.6778± .0704	6.2666± .0393	72.4445± .2925	51.7778± .2793
phæa	7	16.2929± .1114	9.7857± .1085	59.7857± .6050	8.5286± .1261	6.0714± .1070	71.0715± .6223	52.2943± .7043
lyra	81	16.7313± .0471	9.9568± .0217	59.4630± .1482	8.8111± .0238	6.3592± .0183	72.2037± .1972	52.6481± .1296
subzonata	9	16.6833± .0982	9.9222± .0777	59.2778± .2060	8.5889± .0674	6.2556± .0591	72.9444± .3837	51.2778± .3314
Matapoopoo east, 1923, all	115	16.7221± .0379	9.9244± .0200	59.3348± .1227	8.7556± .0216	6.3191± .0171	72.2305± .1568	52.3783± .1164
Whole Matapoopoo area	884	16.5015± .0156	9.6265± .0085	58.2856± .0478	8.6783± .0082	6.1756± .0060	71.0215± .0518	52.5124± .0385
Standard deviation								
Matapoopoo, 1909, apex	3	0.4899±0.0798	0.0943±0.0259	2.4942±0.6868	0.1886±0.0519	0.0943±0.0259	1.2472±0.3434	0.6165±0.2248
lyra	55	.7879± .0506	.3545± .0227	1.8883± .1214	.3516± .0226	.2199± .0141	2.3492± .1510	1.7652± .1135
zonata	2	.9000± .3035	.1000± .0337	2.5000± .8431	.2000± .0674	.1000± .0337	0.5000± .1686	1.0000± .3372
Matapoopoo, 1909, all	60	.7907± .0486	.3414± .0210	1.9779± .1217	.3414± .0210	.2139± .0131	2.2888± .1409	1.7540± .1080
Matapoopoo, 1919, apex	8	.4918± .0829	.1732± .0292	2.2220± .3747	.2236± .0377	.1000± .0168	2.3979± .4043	1.2183± .2054
lyra	177	.7781± .0278	.3477± .0124	2.0514± .0735	.3698± .0132	.2587± .0092	2.0881± .0748	1.6964± .0608
zonata	4	.5356± .1282	.1414± .0337	1.2990± .3098	.2598± .0619	.1000± .0238	1.6394± .3909	2.1650± .5162
Matapoopoo, 1919, all	189	.7657± .0265	.3395± .0117	2.0607± .0715	.3630± .0126	.2548± .0088	2.1734± .0754	1.6937± .0587
Matapoopoo west, 1923, apex	33	.5847± .0485	.3357± .0278	1.8662± .1549	.3483± .0289	.2516± .0208	2.0454± .1698	1.3264± .1101
phæa	5	.6573± .1401	.1959± .0418	2.0396± .4350	.2191± .0466	.0800± .0170	1.2649± .2697	1.0198± .2175
lyra	456	.6507± .0145	.3648± .0081	2.1092± .0471	.3552± .0079	.2470± .0055	2.2043± .0492	1.6669± .0372
zonata	13	.5014± .0663	.3476± .0459	2.3332± .3086	.3775± .0499	.2374± .0314	1.8179± .2405	1.7166± .2270
subzonata	13	.5816± .0769	.3467± .0458	1.6712± .2210	.3775± .0499	.2498± .0330	1.9669± .2601	1.5877± .2100
Matapoopoo west, 1923, all	520	.6468± .0135	.3637± .0076	2.1007± .0439	.3575± .0075	.2484± .0051	2.1724± .0454	1.6469± .0344
Matapoopoo east, 1923, apex	18	.5336± .0599	.3464± .0390	1.8526± .2082	.3326± .0498	.2472± .0278	1.8401± .2068	1.7571± .1904
phæa	7	.4370± .0788	.4257± .0767	2.3733± .4278	.4949± .0891	.4199± .0756	2.4412± .4400	2.7627± .4980
lyra	81	.6284± .0333	.2901± .0153	1.9779± .1048	.3174± .0168	.2443± .0129	2.6314± .1394	1.7293± .0916
subzonata	9	.4269± .0694	.3457± .0549	0.9162± .1456	.2998± .0476	.2630± .0418	1.7069± .2713	1.4741± .2343
Matapoopoo east, 1923, all	115	.6027± .0268	.3189± .0141	1.9513± .0867	.3445± .0152	.2715± .0121	2.4928± .1109	1.8517± .0823
Whole Matapoopoo area	884	.6904± .0110	.3733± .0060	2.1091± .0338	.3625± .0044	.2638± .0042	2.2852± .0366	1.6961± .0272

TABLE 62—*Partula mirabilis. Fecundity*

Series	Year	Records	No. of gravid	Per cent gravid	Eggs	Young	Total contents	Average for gravid	Average for all
Oio	1919	[illegible]	.....	.....	.....	.....	.....	....	....
Vaianai	1923	70	56	80.00	83	56	139	2.48	1.99
Faataofe	1923	134	126	94.03	109	179	288	2.28	2.15
Faataofe	1924	396	383	96.71	541	325	866	2.26	2.19
Mouaroa	1924	26	18	69.23	20	20	40	2.22	1.54
Maramu	1909	312	274	87.82	296	349	645	2.35	2.07
Maramu	1919	33	28	84.84	37	23	60	2.14	1.82
Maramu	1923	50	44	88.00	38	49	87	1.98	1.74
Maramu	1924	206	191	92.72	271	220	491	2.57	2.38
Tefeo	1923	445	395	88.76	429	531	960	2.43	2.16
Tefeo east	1923	784	663	84.57	833	810	1,643	2.48	2.10
Fareaito	1923	128	113	88.28	97	163	260	2.30	2.03
Fareaito	1924	260	228	87.69	275	258	533	2.34	2.05
Irua west	1919	48	40	83.33	54	26	80	2.00	1.66
Irua east	1919	137	114	83.21	105	129	234	2.05	1.71
Irua south	1923	233	219	93.99	290	326	616	2.73	2.64
Ririofau	1924	22	21	95.45	34	25	59	2.81	2.68
Matapoopoo	1909	69	54	78.26	60	39	99	1.83	1.43
Matapoopoo	1919	178	157	89.33	186	100	286	1.82	1.61
Matapoopoo west	1923	568	503	88.56	570	553	1,123	2.23	1.98
Matapoopoo east	1923	47	39	82.98	47	38	85	2.18	1.81
Summary	....	4,146	3,666	88.42	4,375	4,219	8,594	2.34	2.07

TABLE 63—*Partula mirabilis. Recorded adults and their embryonic contents*

Number of eggs	Number of young					Totals
	[illegible]	1	2	3	[illegible]	
0	480	165	117	7	..	769
1	457	1,133	769	52	1	2,412 } 4,375
2	219	487	218	[illegible]	..	933 } eggs
3	18	[illegible]	5	..	..	31 }
4	1	.....	.....	..	..	1 }
Totals...	1,175	1,793	1,109	68	1	4,146 records
	4,219 young					

Summary	Embryonic contents					
	[illegible]	1	2	3	[illegible]	5
Number of adults: 4,146..	480	622	1,469	1,281	279	15

TABLE 64—*Partula mirabilis, Matapoopoo Valley. Color characters of embryonic young*

Parents	Young			
	Plain, ± brown	zonata	lyra	All
apex	31	17	..	48
phæa	3	1	..	4
lyra	229	404	7	640
zonata	14	1	..	15
subzonata	20	3	..	23
Total....	297	426	7	730

TABLE 65—*Partula mooreana. Statistical Description*

Series	No.	Shell						Aperture						Length aperture ÷ length shell, proportions	
		Length		Width		Proportions		Length		Width		Proportions			
		mm.		*mm.*		*p. ct.*		*mm.*		*mm.*		*p. ct.*		*p. ct.*	
Outer circle:															
Haapiti, 1923	33	16.25	−19.55	9.3	−11.1	50.5	−62.5	8.9	−10.5	6.5	−7.9	68.5	−78.5	50.5	−59.5
Oio, 1919	98	15.95	−20.75	8.9	−10.9	51.5	−60.5	8.5	−11.5	6.5	−8.1	66.5	−78.5	50.5	−57.5
Oio, 1923	119	16.25	−19.55	9.1	−11.1	50.5	−60.5	8.7	−10.9	6.3	−7.9	67.5	−81.5	50.5	−59.5
Vaianai, 1907	521	15.65	−19.85	9.1	−11.3	49.5	−63.5	8.1	−10.9	6.1	−7.7	66.5	−80.5	48.5	−59.5
Vaianai, 1919	370	14.75	−18.95	8.7	−10.9	51.5	−63.5	7.9	−10.5	6.1	−7.7	67.5	−81.5	45.5	−58.5
Vaianai, 1923	1,145	15.05	−20.15	8.9	−10.9	48.5	−64.5	8.1	−10.9	6.1	−7.9	64.5	−80.5	47.5	−61.5
Paahonu, 1919	1	17.45		10.5		60.5		9.5		7.1		74.5		54.5	
Atimaha, 1907	14	14.45	−17.45	9.1	−10.1	57.5	−63.5	8.1	− 9.3	5.9	−6.9	70.5	−74.5	52.5	−58.5
Atimaha, 1919	526	13.85	−17.75	7.9	−10.5	52.5	−65.5	7.5	− 9.5	5.5	−7.3	68.5	−82.5	49.5	−59.5
Atimaha, 1923	620	13.85	−17.75	8.1	−10.1	50.5	−66.5	6.9	− 9.9	5.5	−7.3	66.5	−84.5	46.5	−60.5
Inner circle:															
Tefeo, 1923	88	16.85	−20.15	9.3	−11.3	51.5	−60.5	8.7	−10.9	6.3	−8.1	67.5	−77.5	49.5	−57.5
Maramu, 1909	44	16.55	−19.85	10.1	−11.5	49.5	−62.5	9.3	−10.7	6.5	−7.7	65.5	−74.5	51.5	−59.5
Maramu, 1919	94	16.85	−19.85	9.7	−11.3	51.5	−61.5	8.9	−10.9	6.3	−8.1	64.5	−77.5	49.5	−57.5
Maramu, 1923	452	15.95	−20.15	9.1	−11.3	50.5	−61.5	8.5	−11.1	6.1	−8.1	66.5	−80.5	48.5	−60.5
Maramu, 1924	973	15.65	−20.45	8.9	−11.5	50.5	−64.5	8.1	−10.9	5.9	−7.7	64.5	−78.5	47.5	−58.5
Faataofe, 1923	197	16.25	−20.15	8.7	−11.1	49.5	−60.5	8.7	−11.1	6.1	−7.7	65.5	−77.5	48.5	−57.5
Faataofe, 1924	192	16.55	−20.45	9.3	−11.5	52.5	−62.5	8.9	−10.9	6.3	−7.7	66.5	−78.5	48.5	−58.5
Fanautaata, 1923	6	17.45	−18.95	9.5	−10.7	51.5	−57.5	9.3	−10.5	6.7	−7.5	70.5	−73.5	51.5	−55.5
Roroie, 1923	51	16.85	−19.55	9.5	−10.7	51.5	−59.5	9.3	−10.9	6.3	−7.5	65.5	−77.5	50.5	−58.5
Whole series	5,544	13.85	−20.75	7.9	−11.5	48.5	−66.5	6.9	−11.5	5.5	−8.1	64.5	−84.5	45.5	−61.5

Range (class values). Sinistral and dextral shells

TABLE 65—*Partula mooreana*. *Statistical Description*—Continued

Mean value. Sinistral shells												
Outer circle:												
Haapiti, 1923	33	17.7954 ±	0.0846	10.1424 ±	0.0403	56.9242 ±	0.3457	9.6697 ±	0.0533	7.0818 ±	0.0339	73.3485 ±	0.3297	54.1970 ±	0.2054
Oio, 1919	98	18.1265 ±	.0586	10.1000 ±	.0272	55.6224 ±	.1537	9.7469 ±	.0348	7.1857 ±	.0247	73.5612 ±	.1735	53.7245 ±	.1082
Oio, 1923	119	18.0021 ±	.0443	10.1185 ±	.0241	56.1218 ±	.1486	9.7521 ±	.0243	7.1891 ±	.0200	73.5336 ±	.1450	54.1387 ±	.1071
Vaianai, 1907	521	17.7759 ±	.0211	10.1146 ±	.0110	56.8090 ±	.0678	9.4889 ±	.0124	6.8879 ±	.0093	72.5134 ±	.0680	53.2850 ±	.0510
Vaianai, 1919	370	17.1159 ±	.0260	9.8632 ±	.0122	57.5378 ±	.0804	9.2843 ±	.0137	6.8632 ±	.0105	73.7621 ±	.0815	54.1946 ±	.0655
Vaianai, 1923	1,145	17.4479 ±	.0133	9.8797 ±	.0071	56.5236 ±	.0433	9.4979 ±	.0078	6.9414 ±	.0062	73.0354 ±	.0451	54.3201 ±	.0353
Paahonu, 1919[1]	1	17.45		10.50		60.5		9.50		7.10		74.5		54.5	
Atimaha, 1907	14	15.8427 ±	.1275	9.5571 ±	.0499	60.2143 ±	.2844	8.6285 ±	.0603	6.3571 ±	.0552	73.5000 ±	.2044	54.3572 ±	.3328
Atimaha, 1919	526	15.5388 ±	.0188	9.1954 ±	.0099	59.1293 ±	.0640	8.4209 ±	.0100	6.3061 ±	.0081	74.7794 ±	.0666	54.0494 ±	.0516
Atimaha, 1923	620	15.5919 ±	.0176	9.1519 ±	.0094	58.6435 ±	.0618	8.4829 ±	.0106	6.3010 ±	.0082	74.1097 ±	.0645	54.2226 ±	.0521
Inner circle:															
Tefeo, 1923	88	18.3159 ±	.0501	10.2023 ±	.0266	55.5454 ±	.1441	9.7091 ±	.0309	6.9909 ±	.0222	71.9204 ±	.1528	52.9204 ±	.1171
Maramu, 1909	42	18.3857 ±	.0881	10.6619 ±	.0315	58.0000 ±	.2531	10.0714 ±	.0458	7.0857 ±	.0292	70.2381 ±	.2045	54.7619 ±	.1774
Maramu, 1919	94	18.4204 ±	.0434	10.4489 ±	.0264	56.7021 ±	.1524	9.9447 ±	.0284	7.2128 ±	.0223	72.3724 ±	.1421	53.8617 ±	.1314
Maramu, 1923	451	17.9921 ±	.0236	10.2437 ±	.0116	56.9279 ±	.0735	9.6681 ±	.0129	7.0202 ±	.0098	72.5865 ±	.0736	53.6042 ±	.0564
Maramu, 1924	972	17.8954 ±	.0165	10.2075 ±	.0081	56.9722 ±	.0466	9.5378 ±	.0092	6.8486 ±	.0065	71.7736 ±	.0480	53.1996 ±	.0398
Faataofe, 1923	197	18.2602 ±	.0321	10.0939 ±	.0171	55.1599 ±	.0996	9.8035 ±	.0179	7.0503 ±	.0142	71.8452 ±	.1004	53.5609 ±	.0748
Faataofe, 1924	187	18.3276 ±	.0335	10.4229 ±	.0187	56.7834 ±	.0981	9.8080 ±	.0200	7.0251 ±	.0139	71.5535 ±	.1003	53.4465 ±	.0884
Fanautaata, 1923	6	18.0500 ±	.1349	10.1000 ±	.1054	55.8333 ±	.6088	9.8333 ±	.1038	7.0333 ±	.0821	72.0000 ±	.2636	54.3333 ±	.4026
Roroie, 1923	51	18.2147 ±	.0594	10.1863 ±	.0275	55.9706 ±	.1327	9.9785 ±	.0374	7.1039 ±	.0298	71.2843 ±	.2159	54.6568 ±	.1440
Whole series	5,535	17.3159 ±	.0107	9.8897 ±	.0049	57.1560 ±	.0220	9.3378 ±	.0056	6.8130 ±	.0037	72.9262 ±	.0225	53.8273 ±	.0168
Standard deviation. Sinistral shells															
Outer circle:															
Haapiti, 1923	33	0.7203 ±	0.0598	0.3438 ±	0.0285	2.9442 ±	0.2444	0.4542 ±	0.0377	0.2886 ±	0.0240	2.8082 ±	0.2331	1.7492 ±	0.1452
Oio, 1919	98	.8607 ±	.0414	.4000 ±	.0192	2.2555 ±	.1086	.5109 ±	.0246	.3625 ±	.0174	2.5467 ±	.1227	1.5878 ±	.0765
Oio, 1923	119	.7171 ±	.0313	.3898 ±	.0170	2.4030 ±	.1051	.3936 ±	.0172	.3240 ±	.0141	2.4458 ±	.1025	1.7332 ±	.0757
Vaianai, 1907	521	.7138 ±	.0149	.3712 ±	.0078	2.2954 ±	.0479	.4203 ±	.0088	.3139 ±	.0066	2.3012 ±	.0481	1.7259 ±	.0361
Vaianai, 1919	370	.7419 ±	.0184	.3469 ±	.0086	2.2930 ±	.0568	.3924 ±	.0097	.2998 ±	.0074	2.3235 ±	.0576	1.8673 ±	.0463
Vaianai, 1923	1,145	.6693 ±	.0094	.3565 ±	.0050	2.1725 ±	.0306	.3923 ±	.0055	.3108 ±	.0043	2.2611 ±	.0319	1.7739 ±	.0249
Paahonu, 1919	1														
Atimaha, 1907	14	.7074 ±	.0901	.2770 ±	.0353	1.5778 ±	.2011	.3348 ±	.0426	.3064 ±	.0390	1.1339 ±	.1445	1.8461 ±	.2353
Atimaha, 1919	526	.6386 ±	.0133	.3386 ±	.0070	2.1752 ±	.0452	.3399 ±	.0071	.2754 ±	.0057	2.2664 ±	.0471	1.7539 ±	.0365
Atimaha, 1923	620	.6491 ±	.0124	.3480 ±	.0066	2.2839 ±	.0436	.3912 ±	.0074	.3026 ±	.0057	2.3812 ±	.0455	1.9245 ±	.0367
Inner circle:															
Tefeo, 1923	88	.6969 ±	.0354	.3705 ±	.0188	2.0051 ±	.1019	.4306 ±	.0218	.3088 ±	.0157	2.1252 ±	.1080	1.6288 ±	.0828
Maramu, 1909	42	.8465 ±	.0623	.3031 ±	.0223	2.4324 ±	.1789	.4398 ±	.0324	.2808 ±	.0206	1.9647 ±	.1446	1.7051 ±	.1254
Maramu, 1919	94	.6241 ±	.0307	.3795 ±	.0186	2.1908 ±	.1077	.4086 ±	.0201	.3203 ±	.0157	2.0433 ±	.1005	1.8898 ±	.0929
Maramu, 1923	451	.7451 ±	.0167	.3646 ±	.0082	2.3145 ±	.0520	.4075 ±	.0091	.3092 ±	.0069	2.3181 ±	.0520	1.7769 ±	.0399
Maramu, 1924	972	.7652 ±	.0116	.3761 ±	.0057	2.1536 ±	.0329	.4282 ±	.0065	.3014 ±	.0046	2.2207 ±	.0339	1.8421 ±	.0281
Faataofe, 1923	197	.6675 ±	.0227	.3559 ±	.0121	2.0725 ±	.0704	.3730 ±	.0126	.2951 ±	.0100	2.0900 ±	.0710	1.5565 ±	.0529
Faataofe, 1924	187	.6801 ±	.0237	.3792 ±	.0132	1.9892 ±	.0693	.4064 ±	.0141	.2828 ±	.0098	2.0337 ±	.0709	1.7934 ±	.0625
Fanautaata, 1923	6	.4899 ±	.0954	.3829 ±	.0745	2.2111 ±	.4305	.3772 ±	.0734	.2981 ±	.0580	0.9574 ±	.1864	1.4622 ±	.2847
Roroie, 1923	51	.6296 ±	.0420	.2917 ±	.0194	1.4052 ±	.0938	.3962 ±	.0264	.3156 ±	.0211	2.2865 ±	.1526	1.5259 ±	.1018
Whole series	5,535	1.1828 ±	.0075	.5430 ±	.0034	2.4321 ±	.0155	.6222 ±	.0039	.4107 ±	.0026	1.4844 ±	.0159	1.8505 ±	.0119

[1] Class values, Paahonu shell.

TABLE 66—*Partula mooreana. Progressive geographical and annual comparisons. Sinistral shells*

Series	Mean value						
	Shell			Aperture			Length aperture +length shell, proportions
	Length	Width	Proportions	Length	Width	Proportions	
Outer circle:	*mm.*	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Haapiti 1923 / Oio 1923	(+0.2067 ±0.0955)	(−0.0239 ±0.0469)	(−0.8024 ±0.3763)	(+0.0824 ±0.0536)	(+0.1073 ±0.0394)	(+0.1851 ±0.3602)	(−0.0583 ±0.2316)
Oio 1919 / Oio 1923	(− .1244 ± .0734)	(+ .0185 ± .0363)	(+ .4994 ± .2138)	(+ .0052 ± .0424)	(+ .0034 ± .0318)	(− .0272 ± .2261)	(+ .4142 ± .1521)
Vaianai 1907	− .6600 ± .0335	− .2514 ± .0164	+ .7288 ± .1051	− .2046 ± .0185	(− .0247 ± .0140)	+1.2487 ± .1061	+ .9096 ± .0830
Vaianai 1919 / Vaianai 1923	+ .3320 ± .0292	(+ .0165 ± .0141)	−1.0142 ± .0913	+ .2136 ± .0158	+ .0782 ± .0122	− .7267 ± .0931	(+ .1255 ± .0744)
Oio 1919 / Vaianai 1919	−1.0106 ± .0641	− .2368 ± .0298	+1.9154 ± .1734	− .4626 ± .0374	− .3245 ± .0268	(+ .1909 ± .1917)	+ .4701 ± .1265
Oio 1923 / Vaianai 1923	− .5542 ± .0463	− .2388 ± .0253	(+ .4018 ± .1548)	− .2542 ± .0255	− .2477 ± .0209	− .4982 ± .1518	(+ .1814 ± .1127)
Atimaha 1907	(− .3039 ± .1289)	− .3617 ± .0509	−1.0850 ± .2915	− .2076 ± .0611	(− .0510 ± .0558)	+1.2794 ± .2150	(− .3078 ± .3368)
Atimaha 1919 / Atimaha 1923	(+ .0531 ± .0258)	− .0435 ± .0137	− .4858 ± .0889	+ .0620 ± .0146	(− .0051 ± .0115)	− .6697 ± .0928	(+ .1732 ± .0733)

TABLE 66—*Partula mooreana. Progressive geographical and annual comparisons. Sinistral shells*—Continued

Series	Mean value						
	Shell			Aperture			Length aperture ÷length shell, proportions
	Length	Width	Proportions	Length	Width	Proportions	
	mm.	*mm.*	*p. cl.*	*mm.*	*mm.*	*p. cl.*	*p. cl.*
Vaianai 1907 / Atimaha 1907	−1.9332± .1292	− .5575± .0511	+3.4053± .2924	− .8604± .0616	− .5308± .0560	+ .9866± .2154	+1.0722± .3367
Vaianai 1919 / Atimaha 1919	−1.5779± .0321	− .6678± .0157	+1.5915± .1027	− .8634± .0170	− .5571± .0133	+1.0173± .1052	(− .1452± .0834)
Vaianai 1923 / Atimaha 1923	−1.8560± .0221	− .7278± .0118	+2.1199± .0755	−1.0150± .0131	− .6404± .0103	+1.0743± .0787	(− .0975± .0629)
Vaianai 1923 / Maramu 1923	+ .4442± .0271	+ .3640± .0136	+ .4043± .0853	+ .1702± .0150	+ .0788± .0116	− .4489± .0863	+ .2841± .0665
Inner circle: Tefeo 1923 / Maramu 1923	− .3238± .0554	(+ .0414± .0290)	+1.3825± .1618	(− .0410± .0335)	(+ .0293± .0243)	+ .6661± .1696	+ .6838± .1199
Maramu 1909 / Maramu 1919	(+ .0347± .0982)	− .2130± .0411	−1.2979± .2953	(− .1267± .0539)	+ .1361± .0367	+2.1343± .2490	− .8502± .2206
Maramu 1923 / Maramu 1924	− .4283± .0494	− .2052± .0288	(+ .2258± .1690)	− .2766± .0312	− .1926± .0244	(+ .2141± .1600)	(− .2575± .1428)
	− .0967± .0288	− .0362± .0142	(+ .0443± .0870)	− .1303± .0159	− .1716± .0118	− .8129± .0879	− .4046± .0690
Maramu 1923 / Faataofe 1923	+ .2681± .0361	− .1502± .0207	− .7680± .1238	+ .1354± .0220	(+ .0301± .0173)	− .7413± .1243	(− .0433± .0937)
Faataofe 1923 / Faataofe 1924	(+ .0674± .0495)	+ .3290± .0253	+ .6235± .1398	(+ .0045± .0268)	(− .0252± .0198)	(− .2917± .1417)	(− .1144± .1158)
Faataofe 1923 / Fanautaata 1923	(− .2102± .1387)	(+ .0061± .1066)	(+ .6734± .7168)	(+ .0298± .1053)	(− .0170± .0833)	(+ .1548± .3768)	(+ .7724± .4095)
Fanautaata 1923 / Roroie 1923	(+ .1647± .1474)	(+ .0863± .1087)	(+ .1373± .6231)	(+ .1452± .1103)	(+ .0706± .0873)	(− .7157± .4226)	(+ .3235± .4276)

TABLE 67—*Partula mooreana. Statistics of tooth-development*

Series	Year	No.	Index					Average
			1	2	3	4	5	
Outer circle:								
Haapiti	1923	38	1	21	10	5	1	2.5789
Oio	1919	111	..	76	28	3	4	2.4144
Oio	1923	127	..	56	49	12	10	2.8111
Vaianai	1907	523	5	91	314	82	31	3.0822
Vaianai	1919	389	2	176	166	34	11	2.6811
Vaianai	1923	1,171	6	474	536	122	33	2.5901
Paahonu	1919	1	..	1	...	...	..	2.0000
Atimaha	1907	14	..	3	8	3	..	3.0000
Atimaha	1919	572	4	442	108	13	5	2.2535
Atimaha	1923	676	3	410	223	27	13	2.4630
Inner circle:								
Tefeo	1923	93	..	55	29	5	3	2.5377
Maramu, sin	1909	48	..	15	28	4	1	2.8125
dex	1909	2	..	...	1	..	1	4.0000
Maramu	1919	98	..	29	52	14	3	2.9082
Maramu, sin	1923	494	2	343	119	19	11	2.3806
dex	1923	1	..	...	...	1	..	4.0000
Maramu, sin	1924	1,091	10	895	164	17	5	2.1861
dex	1924	1	..	1	...	..	..	2.0000
Faataofe	1923	211	2	135	57	13	4	2.4407
Faataofe, sin	1924	224	12	148	51	8	5	2.3125
dex	1924	4	..	4	...	...	..	2.0000
Fanautaata	1923	6	..	2	3	1	..	2.8333
Roroie	1923	56	..	44	8	3	1	2.3036
Summary:								
Outer circle	....	3,622	21	1,750	1,442	301	108	2.6479
Inner circle	....	2,330	26	1,671	512	86	34	2.3262
Whole series	....	5,952	47	3,421	1,954	387	142	2.5221

TABLE 68—*Partula mooreana. Statistical description of the color classes. Outer circle*

Series	No.	Mean value							
		Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Haapiti, 1923, pallida	7	17.9214±0.1466	10.1571±0.0804	56.6428±0.6006	9.7857±0.1119	7.2143±0.0371	73.3572±0.6871	54.6428±0.3956
fusca	22	17.7636± .0951	10.1636± .0523	57.0909± .4284	9.7000± .0619	7.1000± .0416	73.3637± .4074	54.4091± .2371
fulva	4	17.7500± .4144	10.0000± .0754	56.5000±1.1906	9.3000± .1617	6.7500± .0735	73.2500± .9650	52.2500± .4381
Haapiti, 1923, all	33	17.7954± .0846	10.1424± .0403	56.9242± .3457	9.6697± .0533	7.0818± .0339	73.3485± .3297	54.1970± .2054
Oio, 1919, pallida	18	17.8833± .1008	10.0556± .0715	56.0000± .3903	9.5445± .0667	7.1112± .0565	74.1666± .3747	53.2223± .2296
fusca	74	18.1959± .0819	10.1054± .0313	55.4865± .1722	9.7892± .0419	7.1946± .0292	73.3649± .2095	53.7703± .1258
fulva	6	18.0000± .1747	10.1666± .0410	56.1666± .6490	9.8333± .0687	7.3000± .0449	74.1666± .4105	54.6666± .3341
Oio, 1919, all	98	18.1265± .0586	10.1000± .0272	55.6224± .1537	9.7469± .0348	7.1857± .0247	73.5612± .1735	53.7245± .1082
Oio, 1923, pallida	19	18.1289± .1042	10.3210± .0480	56.9737± .3306	9.8158± .0543	7.2684± .0484	73.9737± .3965	53.8684± .2142
fusca	92	17.9685± .0520	10.0761± .0267	55.9456± .1736	9.7217± .0268	7.1695± .0223	73.5109± .1742	54.1522± .1237
fulva	8	18.0875± .1098	10.1250± .1179	56.1250± .3943	9.7250± .1389	7.2250± .0788	74.2500± .3097	54.6250± .4834
Oio, 1923, all	119	18.0021± .0443	10.1185± .0241	56.1318± .1486	9.7521± .0243	7.1891± .0200	73.5336± .1450	54.1387± .1071
Vaianai, 1907, pallida	64	17.7922± .0616	10.0594± .0325	56.3438± .1978	9.3625± .0378	6.7906± .0240	72.5469± .2007	52.4844± .1386
fusca	376	17.7404± .0241	10.0979± .0129	56.8457± .0783	9.4899± .0143	6.8883± .0109	72.4947± .0816	53.4043± .0594
fulva	8	18.4625± .2053	10.1500± .0462	54.8750± .6519	9.7250± .0732	6.9250± .0556	71.3750± .3663	52.5000± .4769
frenata	73	17.8692± .0574	10.2452± .0276	57.3397± .1772	9.5685± .0335	6.9656± .0251	72.7055± .1589	53.4589± .1296
Vaianai, 1907, all	521	17.7759± .0211	10.1146± .0110	56.8090± .0678	9.4889± .0124	6.8879± .0093	72.5134± .0680	53.2850± .0510
Vaianai, 1919, pallida	79	17.2221± .0555	9.7937± .0276	56.8545± .1532	9.3937± .0305	6.9075± .0229	73.4114± .1721	54.4620± .1341
fusca	277	17.0764± .0296	9.8769± .0136	57.7346± .0943	9.2495± .0153	6.8495± .0120	73.8863± .0948	54.1174± .0773
fulva	5	17.4500± .2141	10.0600± .0591	57.3000± .5189	9.3400± .0965	6.9000± .0539	73.3000± .5849	53.9000± .4091
frenata	9	17.2166± .2288	9.4444± .1076	57.6111± .5076	9.3666± .1199	6.8778± .0859	73.2778± .4713	54.3889± .3252
Vaianai, 1919, all	370	17.1159± .0260	9.8632± .0122	57.5378± .0804	9.2843± .0137	6.8632± .0105	73.7621± .0815	54.1946± .0655
Vaianai, 1923, lower, pallida	68	17.3662± .0511	9.9823± .0262	57.3823± .1727	9.4294± .0287	6.9059± .0217	73.0882± .1649	54.0735± .1273
fusca	333	17.4059± .0235	9.8940± .0128	56.8273± .0801	9.5060± .0136	6.9510± .0114	73.0706± .0853	54.5180± .0644
fulva	24	17.3625± .1036	9.8333± .0447	56.4584± .3150	9.4500± .0430	6.9416± .0389	73.3750± .2956	54.5833± .2100
phæa[1]	1	18.25	10.30	56.50	9.70	7.10	73.50	53.50
frenata	10	17.5400± .1718	9.8200± .0693	56.2000± .3446	9.5000± .0714	6.9800± .0391	74.3000± .2487	54.2000± .3575
cingulata	3	17.6500± .1101	9.9666± .0367	56.5000± .3179	9.7666± .0971	7.1000± .0636	72.8333± .1836	55.5000± .5507
Vaianai, 1923, lower, all	438	17.4034± .0208	9.9041± .0111	56.8767± .0697	9.4932± .0117	6.9457± .0096	73.1164± .0721	54.4498± .0551

TABLE 68—*Partula mooreana. Statistical description of the color classes. Outer circle*—Continued

Series	No.	Mean value						
		Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Vaianai, 1923, upper, pallida	72	17.5666±0.0544	9.8166±0.0326	55.8889±0.1472	9.4611±0.0318	6.9278±0.0277	73.1389±0.1661	53.8611±0.1529
fusca	569	17.4663± .0196	9.8561± .0100	56.3366± .0618	9.5017± .0116	6.9376± .0088	72.9637± .0636	54.2681± .0507
fulva	34	17.4853± .0742	9.9000± .0376	56.3530± .2693	9.5471± .0463	6.9588± .0352	73.0588± .3176	54.3530± .2102
phæa	2	18.2000± .1526	10.3000± .1908	56.5000± .4769	9.8000± .2384	7.3000± .0954	73.5000± .9539	53.5000± .9539
frenata	21	17.3786± .0638	9.9190± .0595	56.8333± .2459	9.5762± .0612	6.9762± .0556	72.6905± .3976	54.8333± .2460
bisecta	9	17.3500± .0841	9.7888± .0706	56.1666± .4620	9.3445± .0663	6.8556± .0509	73.0556± .5094	53.8333± .2119
Vaianai, 1923, upper, all	707	17.4755± .0173	9.8564± .0092	56.3048± .0545	9.5008± .0103	6.9388± .0080	72.9852± .0577	54.2398± .0458
Vaianai, 1923, all	1,145	17.4479± .0133	9.8747± .0071	56.5236± .0433	9.4979± .0078	6.9414± .0062	73.0354± .0451	54.3201± .0353
Paahonu, 1919[1]	1	17.45	10.50	60.50	9.50	7.00	74.5	54.50
Atimaha, 1907, pallida	7	15.6500± .1686	9.5285± .0750	60.6428± .3175	8.5571± .0992	6.2429± .0992	73.4429± .3602	54.3572± .4400
fusca	6	16.0500± .2270	9.6000± .0762	59.8333± .5192	8.6666± .0866	6.4666± .0587	74.1666± .1298	54.1667± .3514
fulva[1]	1	15.95	9.50	59.50	8.90	6.50	73.50	55.50
Atimaha, 1907, all	14	15.8427± .1275	9.5571± .0499	60.2143± .2844	8.6285± .0603	6.3571± .0552	73.5000± .2044	54.3572± .3328
Atimaha, 1919, pallida	60	15.6650± .0624	9.3033± .0263	59.2666± .2176	8.4266± .0306	6.3033± .0221	74.5500± .1752	53.6000± .1595
fusca	371	15.5513± .0219	9.2073± .0120	59.1820± .0749	8.4348± .0120	6.3264± .0099	74.9366± .0805	54.0849± .0622
fulva	62	15.4468± .0536	9.0936± .0280	58.7903± .1930	8.3645± .0285	6.2161± .0203	74.0968± .1730	54.0968± .1254
phæa	19	15.3026± .0967	9.0790± .0425	59.1842± .3056	8.3947± .0367	6.2579± .0409	74.3947± .3982	54.7105± .2438
frenata	10	15.5000± .1153	9.0600± .0533	58.4000± .2515	8.4200± .0666	6.3200± .0554	75.1000± .5659	54.2000± .4376
cingulata	4	15.1250± .3220	8.9500± .0559	59.0000± .1686	8.0500± .0292	6.0500± .0559	75.2500± .3675	53.2500± .1460
Atimaha, 1919, all	526	15.5388± .0188	9.1954± .0099	59.1293± .0640	8.4209± .0100	6.3061± .0081	74.7794± .0666	54.0494± .0516
Atimaha, 1923, lower, pallida	63	15.5405± .0573	9.1794± .0273	58.9762± .2008	8.4429± .0339	6.3190± .0245	74.6428± .1725	54.1508± .1734
fusca	151	15.7334± .0354	9.2019± .0185	58.4272± .1244	8.5742± .0203	6.3940± .0158	74.4073± .1313	54.2748± .0983
fulva	28	15.6607± .0617	9.2643± .0384	59.1785± .2075	8.6643± .0496	6.5000± .0312	75.0357± .3646	55.3214± .2156
phæa	5	15.2900± .0677	9.1000± .1009	58.9000± .6497	8.3400± .0591	6.1400± .0241	73.9000± .4091	53.5000± .6327
frenata	8	16.2500± .2146	9.4280± .0981	58.0000± .7634	8.7750± .1368	6.6000± .0859	74.8750± .5583	53.8750± .3759
cingulata	16	15.8000± .1043	8.8750± .0490	56.3125± .4182	8.4125± .0559	6.1750± .1343	73.4375± .4712	52.9375± .2857
Atimaha, 1923, lower, all	271	15.6921± .0268	9.1886± .0140	58.5037± .0908	8.5450± .0160	6.3760± .0120	74.4742± .0984	54.2491± .0779
Atimaha, 1923, upper, pallida	61	15.4631± .0578	9.0945± .0320	58.8115± .1950	8.4115± .0309	6.2639± .0264	74.2869± .2256	54.2377± .1712
fusca	244	15.5000± .0267	9.1139± .0147	58.7336± .0944	8.4164± .0165	6.2180± .0125	73.7295± .0971	54.1189± .0849
fulva	26	15.5116± .0662	9.1846± .0476	59.1154± .2673	8.4846± .0461	6.3000± .0395	73.8077± .2690	54.5769± .2375
phæa	13	16.0654± .1275	9.3615± .0557	58.2693± .5038	8.7769± .0681	6.5000± .0415	73.6539± .4454	54.7307± .3211
cingulata	5	15.4100± .2246	9.0200± .0818	58.3000± .6718	8.4600± .1396	6.2200± .0818	73.5000± .8531	54.5000± .1907
Atimaha, 1923, upper, all	349	15.5142± .0229	9.1235± .0126	58.7521± .0799	8.4347± .0139	6.2427± .0107	73.8266± .0840	54.2021± .0701
Atimaha, 1923, all	620	15.5919± .0176	9.1519± .0094	58.6435± .0618	8.4829± .0106	6.3010± .0082	74.1097± .0645	54.2226± .0521

[1] Class values.

TABLE 69—*Partula mooreana. Statistical description of the color classes. Outer circle*—Continued

Standard deviation

Series	No.	Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Haapiti, 1923, pallida	7	0.5749±0.1036	0.3156±0.0568	2.3561±0.4247	0.4389±0.0791	0.1457±0.0262	2.6954±0.4858	1.5518±0.2797
fusca	22	.6615± .0672	.3637± .0370	2.9796± .3029	.4306± .0437	.2892± .0294	2.8331± .2881	1.6489± .1676
fulva	4	1.2288± .2930	.2236± .0533	3.5305± .8419	.4796± .1143	.2179± .0520	2.8614± .6823	1.2990± .3098
Haapiti, 1923, all	33	.7203± .0598	.3438± .0285	2.9442± .2444	.4542± .0377	.1886± .0240	2.8082± .2331	1.7492± .1452
Oio, 1919, pallida	18	.6342± .0713	.4499± .0505	2.4551± .2760	.4194± .0471	.3558± .0399	2.3570± .2649	1.4441± .1623
fusca	74	1.0442± .0579	.3999± .0221	2.1964± .1217	.5344± .0296	.3723± .0296	2.6728± .1481	1.6049± .0889
fulva	6	.6344± .1235	.1491± .0290	2.3570± .4589	.2494± .0486	.1633± .0317	1.4907± .2902	1.2134± .2362
Oio, 1919, all	98	.8607± .0414	.4000± .0192	2.2555± .1086	.5109± .0246	.3625± .0174	2.5467± .1227	1.5878± .0765
Oio, 1923, pallida	19	.6732± .0737	.3105± .0339	2.1366± .2337	.3513± .0384	.3131± .0342	2.5652± .2803	1.3845± .1514
fusca	92	.7403± .0367	.3809± .0188	2.4688± .1227	.3816± .0189	.3175± .0157	2.4781± .1232	1.7596± .0874
fulva	8	.4607± .0776	.4943± .0833	1.6536± .2788	.5826± .0982	.3307± .0557	1.2990± .2190	2.0271± .3418
Oio, 1923, all	119	.7171± .0313	.3898± .0170	2.4030± .1051	.3936± .0172	.3240± .0141	2.4458± .1025	1.7332± .0757
Vaianai, 1907, pallida	64	.7305± .0435	.3859± .0230	2.3466± .1399	.4484± .0267	.2849± .0170	2.3811± .1499	1.6440± .0980
fusca	376	.6929± .0170	.3701± .0091	2.2521± .0554	.4105± .0101	.3150± .0077	2.3452± .0577	1.7077± .0420
fulva	8	.8608± .1452	.1936± .0327	2.7339± .4610	.3072± .0518	.2332± .0393	1.5360± .2591	2.0000± .3372
frenata	73	.7276± .0406	.3492± .0195	2.2454± .1253	.4242± .0237	.3177± .0177	2.0133± .1123	1.6422± .0916
Vaianai, 1907, all	521	.7138± .0149	.3712± .0078	2.2954± .0479	.4203± .0088	.3139± .0066	2.3012± .0481	1.7259± .0361
Vaianai, 1919, pallida	79	.7321± .0392	.3640± .0195	2.0191± .1083	.4023± .0215	.3026± .0162	2.2685± .1217	1.7678± .0948
fusca	277	.7298± .0209	.3352± .0096	2.3284± .0667	.3789± .0108	.2964± .0085	2.3392± .0670	1.9071± .0546
fulva	5	.7099± .1514	.1959± .0418	1.7204± .3669	.3200± .0682	.1789± .0381	1.9391± .4136	1.3564± .2893
frenata	9	1.0176± .1618	.4787± .0761	2.5579± .3589	.5333± .0848	.3823± .0607	2.0964± .3332	1.4465± .2299
Vaianai, 1919, all	370	.7419± .0184	.3469± .0086	2.2930± .0568	.3924± .0097	.2998± .0074	2.3235± .0576	1.8673± .0463
Vaianai, 1923, lower, pallida	68	.6256± .0361	.3204± .0185	2.1111± .1221	.3517± .0203	.2656± .0153	2.0164± .1166	1.5559± .0900
fusca	333	.6362± .0166	.3479± .0090	2.1667± .0566	.3690± .0096	.3091± .0080	2.3091± .0603	1.7432± .0455
fulva	24	.7524± .0732	.3249± .0316	2.2981± .2227	.3122± .0304	.2827± .0275	2.1469± .2090	1.5252± .1485
phæa	1							
frenata	10	.8055± .1215	.3249± .0490	1.6155± .2436	.3347± .0505	.1833± .0276	1.1662± .1758	1.6763± .2528
cingulata	3	.2828± .0778	.0943± .0259	0.8165± .2248	.2495± .0686	.1633± .0450	0.4714± .1298	1.4142± .3894
Vaianai, 1923, lower, all	438	.6459± .0147	.3437± .0078	2.1628± .0493	.3645± .0083	.2990± .0068	2.2379± .0510	1.7114± .0389

TABLE 69—*Partula mooreana. Statistical description of the color classes. Outer circle*—Continued

Series	No.	Standard deviation						
		Shell			Aperture			Length aperture ÷length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Vaianai, 1923, upper, pallida	72	0.6848±0.0384	0.4106±0.0230	1.8526±0.1041	0.4009±0.0225	0.3487±0.0196	2.0904±0.1174	1.9243±0.1081
fusca	569	.6931± .0138	.3561± .0707	2.1855± .0437	.4094± .0082	.3127± .0062	2.2496± .0450	1.7950± .0358
fulva	34	.6416± .0524	.3254± .0266	2.3279± .1904	.4001± .0327	.3049± .0249	2.7460± .2246	1.8171± .1486
phæa	2	.3201± .1079	.4000± .1349	1.0000± .3372	.5000± .1686	.2000± .0674	2.0000± .6745	2.0000± .6745
frenata	21	.4333± .0451	.4043± .0421	1.6711± .1739	.4162± .0433	.3778± .0393	2.7013± .2811	1.6714± .1739
bisecta	9	.3741± .0594	.3142± .0499	2.0548± .3267	.2948± .0469	.2266± .0360	2.2660± .3602	0.9428± .1498
Vaianai, 1923, upper, all	707	.6819± .0122	.3631± .0065	2.1497± .0385	.4086± .0073	.3179± .0056	2.2773± .0401	1.8068± .0324
Vaianai, 1923, all	1,145	.6693± .0094	.3565± .0050	2.1725± .0306	.3923± .0055	.3108± .0043	2.2611± .0319	1.7739± .0249
Paahonu, 1919	1							
Atimaha, 1907, pallida	7	.6612± .1192	.2914± .0530	1.2454± .2245	.3499± .0701	.3499± .0701	1.4130± .2547	1.7261± .3311
fusca	6	.8246± .1605	.2769± .0539	1.8856± .3671	.3145± .0612	.2134± .0415	0.4714± .0918	2.0548± .2485
fulva	1							
Atimaha, 1907, all	14	.7074± .0901	.2770± .0353	1.5778± .2011	.3348± .0426	.3064± .0390	1.1339± .1445	1.8461± .2353
Atimaha, 1919, pallida	60	.7171± .0441	.3022± .0186	2.4991± .1538	.3521± .0216	.2542± .0156	2.0118± .1239	1.8321± .1128
fusca	371	.6265± .0155	.3444± .0085	2.1384± .0529	.3428± .0085	.2818± .0070	2.2980± .0569	1.7759± .0440
fulva	62	.6255± .0379	.3272± .0198	2.2532± .1364	.3327± .0201	.2370± .0143	2.0197± .1223	1.4642± .0886
phæa	19	.6252± .0684	.2745± .0300	1.9749± .2160	.2372± .0259	.2642± .0289	2.5733± .2815	1.5754± .1724
frenata	10	.5408± .0815	.2499± .0377	1.1790± .1778	.3124± .0471	.2600± .0392	2.6533± .4001	2.0518± .3094
cingulata	4	.9549± .2277	.1658± .0395	0.5000± .1192	.0866± .0206	.1658± .0395	1.0897± .2598	0.4330± .1032
Atimaha, 1919, all	526	.6386± .0133	.3386± .0070	2.1752± .0452	.3399± .0071	.2754± .0057	2.2664± .0471	1.7539± .0365
Atimaha, 1923, lower, pallida	63	.6746± .0405	.3218± .0193	2.3628± .1419	.3991± .0239	.2889± .0173	2.0304± .1219	2.0405± .1225
fusca	151	.6456± .0250	.3366± .0131	2.2672± .0878	.3694± .0142	.2891± .0111	2.3930± .0927	1.7909± .0694
fulva	28	.4843± .0436	.3018± .0271	1.6283± .1466	.3893± .0351	.2449± .0220	2.8602± .2577	1.6915± .1523
phæa	5	.2245± .0479	.3347± .0712	2.1541± .4593	.1959± .0418	.0800± .0170	1.3564± .2892	2.0976± .4473
frenata	8	.9000± .1517	.4115± .0692	3.2015± .5397	.5739± .0966	.3605± .0606	2.3411± .3947	1.5762± .2657
cingulata	16	.6185± .0737	.2905± .0345	2.4804± .2956	.3314± .0394	.7965± .0948	2.7944± .3331	1.6945± .2019
Atimaha, 1923, lower, all	271	.6552± .0189	.3421± .0099	2.3628± .0683	.3917± .0113	.2940± .0085	2.4014± .0695	1.9007± .0550
Atimaha, 1923, upper, pallida	61	.6701± .0409	.3710± .0226	2.2582± .1378	.3576± .0217	.3062± .0185	2.6121± .1594	1.9827± .1209
fusca	244	.6179± .0189	.3416± .0104	2.1876± .0666	.3832± .0116	.2894± .0088	2.2499± .0685	1.9665± .0599
fulva	26	.5008± .0468	.3602± .0336	2.0206± .1889	.3483± .0325	.2987± .0278	2.0337± .1901	1.7958± .1678
phæa	13	.6814± .0901	.2976± .0393	2.6934± .3561	.3641± .0481	.2220± .0292	2.3809± .3148	1.7166± .2269
cingulata	5	.7446± .1588	.2713± .0577	2.2271± .4749	.4630± .0986	.2713± .0577	2.8284± .6031	0.6324± .1347
Atimaha, 1923, upper, all	349	.6335± .0162	.3499± .0089	2.2147± .0564	.3842± .0097	.2962± .0074	2.3264± .0593	1.9426± .0494
Atimaha, 1923, all	620	.6491± .0124	.3480± .0066	2.2839± .0436	.3912± .0074	.3026± .0057	2.3812± .0455	1.9245± .0367

TABLE 70—*Partula mooreana. Statistical description of the color classes. Inner circle*

Series	No.	Mean value						
		Shell			Aperture			Length aperture ÷length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Tefeo, 1923, pallida	11	18.2409±0.1711	10.2454±0.0603	55.9545±0.3508	9.6091±0.0634	6.8818±0.0636	71.5909±0.3725	52.5909±0.3060
fusca	52	18.4250± .0636	10.2038± .0360	55.2692± .1989	9.7615± .0414	7.0346± .0261	72.0192± .1937	52.8461± .1533
fulva	17	18.0853± .1036	10.1353± .0685	55.8529± .2745	9.5941± .0754	6.9000± .0654	71.7353± .3786	53.0294± .2516
phæa	8	18.2000± .1290	9.9250± .0442	56.1250± .4451	9.7500± .0817	7.0500± .0315	72.1250± .5579	53.5000± .3894
Tefeo, 1923, all	88	18.3159± .0501	10.2023± .0265	55.5454± .1441	9.7091± .0309	6.9909± .0222	71.9204± .1528	52.9204± .1171
Maramu, 1909, sin., pallida	7	18.0500± .2312	10.5572± .0525	58.5000± .5098	9.7857± .1183	6.9857± .0659	71.6428± .2124	54.2243± .4460
fusca	15	18.0300± .1120	10.5400± .0462	58.5000± .2772	9.9000± .0719	7.0333± .0534	70.8333± .3028	54.9000± .2900
frenata	20	18.7700± .1192	10.7900± .0462	57.4500± .4409	10.3000± .0477	7.1600± .0370	69.3000± .2924	54.8500± .2536
Maramu, 1909, sin., all	42	18.3857± .0881	10.6619± .0315	58.0000± .2531	10.0714± .0458	7.0857± .0292	70.2381± .2045	54.7619± .1774
Maramu, 1909, dex., fusca	2	19.7000± .2146	10.6000± .0477	53.5000± .4769	10.7000± .0	7.7000± .0954	71.0000± .7154	55.0000± .7154
Maramu, 1919, sin., pallida	13	18.3500± .1292	10.2077± .0650	55.6539± .3010	9.6386± .0629	7.0077± .0540	72.5000± .3197	52.3462± .3429
fusca	31	18.3790± .0780	10.5193± .0483	57.1774± .3052	10.0032± .0525	7.2678± .0370	72.4678± .2413	54.2742± .2730
fulva	20	18.4100± .0600	10.3700± .0460	56.2500± .3012	9.9700± .0460	7.1700± .0429	71.8500± .3641	54.0000± .1995
phæa	21	18.3643± .0939	10.4810± .0559	57.0714± .3066	9.9381± .0593	7.2333± .0540	72.6905± .2709	54.1191± .2201
frenata	9	18.8166± .1528	10.6555± .0552	56.7222± .3479	10.1444± .0815	7.3666± .0424	72.2778± .4469	53.7223± .2956
Maramu, 1919, sin., all	94	18.4202± .0434	10.4489± .0264	56.7021± .1534	9.9447± .0284	7.2128± .0223	72.3724± .1421	53.8617± .1314
Maramu, 1923, sin, lower, pallida	31	18.2629± .0842	10.3194± .0386	56.4678± .2528	9.6936± .0419	7.1129± .0353	73.2097± .2596	53.0161± .1918
fusca	65	18.0177± .0597	10.2723± .0299	57.0077± .2028	9.6385± .0309	6.9667± .0269	72.3154± .2085	53.4077± .1413
fulva	40	18.0425± .0785	10.2550± .0377	56.8000± .2951	9.6550± .0395	7.0350± .0317	72.9750± .2119	53.3000± .2227
phæa	45	18.2233± .0651	10.2822± .0349	56.3223± .1764	9.8244± .0400	7.0600± .0265	71.6778± .2266	53.7444± .1531
frenata	5	17.9840± .3740	10.1800± .1354	58.5000± .6327	9.3800± .1285	6.9000± .1265	73.5000± .7388	53.1000± .5911
Maramu, 1923, sin., lower, all	186	18.0000± .0358	10.2763± .0174	56.7473± .1155	9.6893± .0192	7.0269± .0151	72.4839± .1161	53.4140± .0868
Maramu, 1923, sin., upper, pallida	34	18.1029± .0920	10.3471± .0389	57.1470± .3122	9.8176± .0393	7.0412± .0315	72.3824± .2760	53.4412± .2295
fusca	104	17.8971± .0470	10.2231± .0234	57.1154± .1352	9.6250± .0265	6.9923± .0187	72.6923± .1354	53.6442± .0968
fulva	55	17.7500± .0624	10.1400± .0309	57.1455± .2197	9.5691± .0379	6.9582± .0283	72.6636± .1991	53.7727± .1863
phæa	69	18.0022± .0642	10.2360± .0331	56.8913± .1895	9.7435± .0369	7.1000± .0278	72.8623± .2119	54.0072± .1518
frenata	3	17.5500± .3611	9.7666± .1323	55.8333± .4857	9.4333± .1468	6.6333± .0971	69.8333± .3671	53.5000± .3179
Maramu, 1923, sin., upper, all	265	17.9159± .0313	10.2205± .0154	57.0568± .0951	9.6530± .0174	7.0152± .0129	72.6591± .0952	53.7386± .0739
Maramu, 1923, sin., all	451	17.9921± .0236	10.2437± .0116	56.9279± .0735	9.6681± .0129	7.0202± .0098	72.5865± .0736	53.6042± .0564
Maramu, 1923, dex., upper, fusca[1]	1	18.95	10.50	55.50	9.70	6.90	71.50	51.50

[1] Class values.

TABLE 70—*Partula mooreana. Statistical description of the color classes. Inner circle*—Continued

Series	No.	Mean value: Shell: Length	Shell: Width	Shell: Proportions	Aperture: Length	Aperture: Width	Aperture: Proportions	Length aperture ÷ length shell, proportions
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Maramu, 1924, sin., pallida	132	17.8909±0.0458	10.1834±0.0194	56.8257±0.1238	9.5045±0.0255	6.8364±0.0170	71.7348±0.1204	52.9470±0.1101
fusca	430	17.8344± .0242	10.1958± .0123	57.1046± .0724	9.5293± .0134	6.8400± .0096	71.7581± .0638	53.3721± .0606
fulva	168	17.9518± .0388	10.2512± .0205	57.0357± .1138	9.5714± .0216	6.8619± .0160	71.6904± .1187	53.1846± .0951
phæa	201	17.9381± .0385	10.1956± .0179	56.7636± .0975	9.5308± .0225	6.8493± .0148	71.8930± .1093	53.0324± .0849
frenata	38	18.1052± .0786	10.2842± .0396	56.8157± .2086	9.6315± .0399	6.9105± .0292	71.7894± .2458	53.0790± .1855
zonata	3	18.1500± .2753	10.3000± .1272	56.8333± .3671	9.6333± .1836	7.0333± .1600	72.1666± .9713	53.1666± .8002
Maramu, 1924, sin., all	972	17.8954± .0165	10.2075± .0081	56.9722± .0466	9.5378± .0092	6.8486± .0065	71.7736± .0480	53.1996± .0398
Maramu, 1924, dex., fusca[1]	1	18.95	10.70	56.50	9.90	7.50	74.50	52.50
Faataofe, 1923, pallida	30	18.5700± .0879	10.2333± .0460	55.0000± .2220	9.9000± .0603	7.1333± .0392	71.8666± .2533	52.9000± .1544
fusca	142	18.1747± .0365	10.0704± .0200	55.2888± .1201	9.7676± .0198	7.0268± .0166	71.8733± .1214	53.6127± .0911
fulva	23	18.2978± .0783	10.0652± .0428	54.8478± .2475	9.8913± .0427	7.0826± .0351	71.6739± .2578	54.0217± .1703
phæa[1]	1	18.95	10.30	54.50	10.10	7.30	72.50	53.50
frenata[1]	1	19.55	9.70	49.50	9.70	6.90	70.50	49.50
Faataofe, 1923, all	197	18.2602± .0321	10.0939± .0171	55.1599± .0996	9.8035± .0179	7.0503± .0142	71.8452± .1004	53.5609± .0748
Faataofe, 1924, sin., pallida	19	18.2337± .1289	10.4579± .0455	57.2368± .2696	9.7211± .0521	7.0263± .0451	72.1315± .3830	53.4474± .2730
fusca	114	18.3894± .0422	10.4333± .0260	56.6754± .1318	9.8351± .0247	7.0315± .0180	71.4299± .1298	53.4035± .1097
fulva	45	18.2300± .0671	10.3844± .0340	56.8333± .1965	9.8112± .0452	7.0155± .0283	71.4778± .1779	53.6777± .1863
phæa	6	18.2000± .1039	10.3666± .0756	56.8333± .3044	9.7333± .1248	6.9666± .0687	71.3333± .2471	53.5000± .5272
frenata	3	18.3500± .0953	10.5000± .0841	57.1666± .1836	9.4333± .1324	7.0333± .0734	74.1666± .1836	51.5000± .6359
Faataofe, 1924, sin., all	187	18.3276± .0335	10.4229± .0187	56.7834± .0981	9.8080± .0200	7.0251± .0139	71.5535± .1003	53.4465± .0884
Faataofe, 1924, dex., fusca	3	17.8500± .3971	10.1000± .0636	56.5000± .8612	9.4333± .1468	6.8333± .0991	72.5000± .5507	52.8333±1.2870
frenata[1]	1	17.15	10.70	62.50	9.50	6.90	73.50	55.50
Faataofe, 1924, dex., all	4	17.6750± .3149	10.2500± .0997	58.0000±1.0797	9.4500± .1106	6.8500± .0653	72.7500± .4831	53.5000± .7349
Fanautaata, 1923, pallida[1]	1	17.75	10.30	57.50	9.90	7.10	71.50	55.50
fusca	5	18.3500± .1557	10.0600± .1230	55.5000± .6878	9.8200± .1029	7.0200± .0980	72.1000± .3378	54.1000± .4514
Fanautaata, 1923, all	6	18.0500± .1349	10.1000± .1054	55.8333± .6088	9.8333± .1038	7.0333± .0821	72.0000± .2636	54.3333± .4076
Roroie, 1923, pallida	12	18.1000± .1066	10.3000± .0318	56.0833± .2805	9.9500± .0731	7.1666± .0535	72.2500± .6365	54.0833± .3321
fusca	36	18.2417± .0680	10.1722± .1017	55.9166± .1971	10.0166± .0489	7.1000± .0371	71.0000± .2078	54.8055± .1997
fulva	3	17.4500± .1652	9.9000± .0636	56.1666± .1836	9.6333± .1323	6.9000± .0636	70.8333± .1836	55.1666± .1836
Roroie, 1923, all	51	18.2147± .0594	10.1863± .0275	55.9706± .1327	9.9785± .0374	7.1039± .0298	71.2843± .2159	54.6568± .1440

[1] Class values.

TABLE 71—*Partula mooreana. Statistical description of the color classes. Inner circle*—Continued

Standard deviation

Series	No.	Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Tefeo, 1923, pallida	11	0.8415±0.1210	0.2966±0.0426	1.7249±0.2480	0.3118±0.0448	0.3128±0.0450	1.8318±0.2634	1.5048±0.2164
fusca	52	.6807± .0450	.3853± .0254	2.1269± .1406	.4429± .0293	.2793± .0184	2.0708± .1369	1.6395± .1084
fulva	17	.6333± .0732	.4186± .0484	1.6783± .1941	.4608± .0533	.4000± .0462	2.3144± .2677	1.5384± .1779
phæa	8	.5409± .0912	.1854± .0312	1.8667± .3147	.3428± .0578	.1323± .0223	2.3397± .3945	1.6329± .2753
Tefeo, 1923, all	88	.6969± .0354	.3705± .0188	2.0051± .1019	.4306± .0218	.3088± .0157	2.1252± .1080	1.6288± .0828
Maramu, 1909, sin., pallida	7	.9071± .1635	.2060± .0371	2.0000± .3605	.4643± .0836	.2587± .0466	0.8331± .1502	1.7497± .3153
fusca	15	.6431± .0792	.2653± .0326	1.5916± .1960	.4131± .0508	.3069± .0377	1.7385± .2141	1.6653± .2050
frenata	20	.7903± .0843	.3064± .0326	2.9236± .3117	.3162± .0337	.2457± .0261	1.9391± .2067	1.6815± .1793
Maramu, 1909, sin., all	42	.8465± .0623	.3031± .0223	2.4324± .1789	.4398± .0324	.2808± .0206	1.9647± .1446	1.7051± .1254
Maramu, 1909, dex., fusca	2	.4500± .1517	.1000± .0337	1.0000± .3372	.0	.2000± .0674	1.5000± .5058	1.5000± .5058
Maramu, 1919, sin., pallida	13	.6961± .0913	.3474± .0459	1.6099± .2128	.3365± .0395	.2895± .0382	1.7097± .2260	1.8333± .2425
fusca	31	.6437± .0551	.3979± .0341	2.5194± .2158	.4333± .0371	.3052± .0262	1.9917± .1706	2.2534± .1930
fulva	20	.3980± .0424	.3051± .0325	1.9969± .2130	.3051± .0325	.2848± .0445	2.4140± .2574	1.3229± .1411
phæa	21	.6379± .0664	.3800± .0395	2.0833± .2168	.4169± .0419	.3669± .0382	1.8418± .1915	1.4953± .1556
frenata	9	.6799± .1080	.2455± .0390	1.5476± .2460	.3624± .0576	.1886± .0300	1.9876± .3160	1.3147± .2090
Maramu, 1919, sin., all	94	.6241± .0307	.3795± .0186	2.1908± .1077	.4086± .0201	.3203± .0157	2.0433± .1005	1.8898± .0929
Maramu, 1923, sin., lower, pallida	31	.6950± .0595	.3187± .0273	2.0866± .1787	.3463± .0296	.2915± .0249	2.1432± .1835	1.5836± .1356
fusca	65	.7140± .0422	.3575± .0211	2.4248± .1434	.3695± .0218	.3221± .0190	2.4924± .1474	1.6896± .0999
fulva	40	.7363± .0555	.3535± .0266	2.7677± .2086	.3701± .0279	.2978± .0224	1.9873± .1498	2.0880± .1575
phæa	45	.6480± .0460	.3472± .0247	1.7548± .1247	.3984± .0283	.2639± .0187	2.2538± .1602	1.5225± .1082
frenata	5	1.2400± .2644	.4490± .0957	2.0976± .4474	.4261± .0908	.4195± .0894	2.4495± .5224	1.9596± .4180
Maramu, 1923, sin., lower, all	186	.7235± .0253	.3517± .0123	2.3356± .0817	.3889± .0136	.3066± .0107	2.3474± .0821	1.7547± .0614
Maramu, 1923, sin., upper, pallida	34	.7953± .0650	.3362± .0275	2.6995± .2207	.3399± .0278	.2724± .0223	2.3858± .1951	1.9844± .1623
fusca	104	.7109± .0332	.3544± .0165	2.0442± .0956	.4011± .0187	.2827± .0132	2.0479± .0957	1.4637± .0684
fulva	55	.6865± .0441	.3398± .0218	2.4162± .1553	.4164± .0268	.3114± .0200	2.1889± .1408	2.0489± .1317
phæa	69	.7906± .0454	.4076± .0234	2.3340± .1340	.4541± .0261	.3422± .0196	2.6097± .1498	1.8698± .1073
frenata	3	.9273± .2553	.3399± .0935	1.2472± .3434	.3771± .1038	.2495± .0686	0.9428± .2596	0.8165± .2248
Maramu, 1923, sin., upper, all	265	.7552± .0221	.3724± .0109	2.1955± .0672	.4202± .0123	.3120± .0091	2.2989± .0673	1.7837± .0522
Maramu, 1923, sin., all	451	.7451± .0167	.3646± .0082	2.3145± .0520	.4075± .0091	.3092± .0069	2.3181± .0520	1.7769± .0399
Maramu, 1923, dex., upper, fusca	1	.....	.....	.....	.....	.....	.....	.....

TABLE 71—*Partula mooreana. Statistical description of the color classes. Inner circle*—Continued

Standard deviation

Series	No.	Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Maramu, 1924, sin., pallida	132	0.7811±0.0324	0.3312±0.0137	2.1088±0.0875	0.4345±0.0180	0.2906±0.0120	2.0518±0.0851	1.8761±0.0778
fusca	430	.7444± .0171	.3803± .0087	2.2261± .0512	.4112± .0095	.2973± .0068	1.9626± .0451	1.8652± .0428
fulva	168	.7460± .0274	.3943± .0145	2.1873± .0804	.4159± .0153	.3085± .0113	2.2808± .0839	1.8286± .0672
phæa	201	.8088± .0272	.3775± .0126	2.0504± .0689	.4734± .0159	.3123± .0104	2.2985± .0773	1.7845± .0600
frenata	38	.7181± .0556	.3624± .0280	1.9071± .1475	.3650± .0282	.2673± .0206	2.2467± .1738	1.6957± .1311
zonata	3	.7071± .1946	.3266± .0899	0.9428± .2596	.4714± .1298	.4109± .1131	2.4944± .6868	2.0548± .5658
Maramu, 1924, sin., all	972	.7652± .0116	.3761± .0057	2.1536± .0329	.4282± .0065	.3014± .0046	2.2207± .0339	1.8421± .0281
Maramu, 1924, dex., fusca	1							
Faataofe, 1923, pallida	30	.7139± .0621	.3736± .0325	1.8028± .1570	.4899± .0426	.3187± .0227	2.0572± .1791	1.2543± .1092
fusca	142	.6460± .0258	.3536± .0141	2.1224± .0849	.3495± .0140	.2940± .0117	2.1448± .0858	1.6105± .0644
fulva	23	.5570± .0553	.3045± .0303	1.7596± .1750	.3035± .0302	.2496± .0248	1.8333± .1823	1.2112± .1204
phæa	1							
frenata	1							
Faataofe, 1923, all	197	.6675± .0227	.3559± .0121	2.0725± .0704	.3730± .0126	.2951± .0100	2.0900± .0710	1.5565± .0529
Faataofe, 1924, sin., pallida	19	.8334± .0911	.2944± .0322	1.7424± .1906	.3365± .0368	.2917± .0319	2.4753± .2715	1.7644± .1930
fusca	114	.6691± .0298	.4126± .0184	2.0869± .0932	.3907± .0174	.2851± .0127	2.0549± .0918	1.7369± .0775
fulva	45	.6675± .0474	.3386± .0240	1.9550± .1389	.4493± .0319	.2812± .0200	1.7700± .1258	1.8534± .1317
phæa	6	.3775± .0734	.2748± .0534	1.1055± .2152	.4534± .0882	.2494± .0486	0.8975± .1747	1.9148± .3728
frenata	3	.2449± .0237	.2160± .0594	0.4714± .1298	.3400± .0936	.1886± .0519	0.4714± .1298	1.6330± .4496
Faataofe, 1924, sin., all	187	.6801± .0237	.3792± .0132	1.9892± .0693	.4064± .0141	.2828± .0098	2.0337± .0709	1.7934± .0625
Faataofe, 1924, dex., fusca	3	1.0198± .2808	.1633± .0450	2.1602± .6089	.3771± .1041	.2494± .0701	1.4142± .3894	3.2998± .9100
frenata	1							
Faataofe, 1924, dex., all	4	.9337± .2226	.2958± .0705	3.2015± .7634	.3279± .0782	.1936± .0462	1.2990± .3416	3.0822± .7349
Fanautaata, 1923, pallida	1							
fusca	5	.5160± .1101	.4079± .0870	2.2803± .4863	.4176± .0890	.3249± .0693	1.0198± .2388	1.4966± .3192
Fanautaata, 1923, all	6	.4899± .0954	.3829± .0745	2.2111± .4305	.3772± .0734	.2981± .0580	1.9574± .1864	1.4622± .2847
Roroie, 1923, pallida	12	.5477± .0754	.1633± .0225	1.4409± .1983	.3753± .0517	.2748± .0378	3.2692± .4501	1.7058± .2348
fusca	36	.6048± .0481	.9045± .0719	1.7539± .1394	.4349± .0346	.3299± .0262	1.8484± .1469	1.7767± .1412
fulva	3	.4242± .1168	.1633± .0450	0.4714± .1298	.3399± .0935	.1633± .0450	0.4714± .1298	0.4714± .1298
Roroie, 1923, all	51	.6296± .0420	.2917± .0194	1.4052± .0938	.3962± .0264	.3156± .0211	2.2865± .1526	1.5259± .1018

TABLE 72—*Partula mooreana. Statistics of fecundity*

Series	Year	Records	No. of gravid	Per cent gravid	Eggs	Young	Total contents	Average for gravid	Average for all
Outer circle:									
Haapiti	1923	33	27	81.82	40	26	66	2.44	2.00
Oio	1919	0	...	.....	....	....	.....	.....	.....
Oio	1923	119	98	82.35	144	92	236	2.41	1.95
Vaianai	1907	482	397	82.37	552	270	822	2.07	1.70
Vaianai	1919	279	225	80.64	229	152	381	1.69	1.36
Vaianai	1923	1,090	857	78.62	970	604	1,574	1.84	1.44
Paahonu	1919	1	1	100.	1	1	2	2.00	2.00
Atimaha	1907	12	11	91.66	12	12	24	2.18	2.00
Atimaha	1919	475	344	72.42	325	222	547	1.59	1.15
Atimaha	1923	510	440	86.27	514	399	913	2.07	1.79
Inner circle:									
Tefeo	1923	85	72	84.71	72	84	156	2.17	1.83
Maramu	1909	51	44	86.27	43	39	82	1.86	1.61
Maramu	1919	78	59	75.64	64	46	110	1.86	1.41
Maramu	1923	457	389	85.12	297	401	698	1.79	1.53
Maramu	1924	1,069	950	88.87	1,139	873	2,012	2.12	1.88
Faataofe	1923	176	162	92.04	153	233	386	2.38	2.19
Faataofe	1924	224	212	94.64	303	201	504	2.38	2.25
Fanautaata	1923	6	6	100.	8	9	17	2.83	2.83
Roroie	1923	53	51	96.23	67	74	141	2.76	2.66
Summary		5,200	4,345	83.56	4,933	3,738	8,671	1.99	1.67

TABLE 73—*Partula mooreana. Recorded adults and their embryonic contents*

Number of eggs	Number of young				Totals	
	0	1	2	3		
0	855	375	94	....	1,324	
1	790	1,641	408	6	2,845	4,933 eggs
2	386	548	71	....	1,005	
3	16	10	...	....	26	
Totals	2,047	2,574	573	6	5,200 records	
		3,738 young				

Summary	Embryonic contents				
	0	1	2	3	4
Number of adults:—5,200	855	1,165	2,121	972	87

TABLE 74—*Partula suturalis vexillum. Atimaha to Pafatu Valleys. Statistical description*

Series	Year	No.	Range (class values)						
			Shell			Aperture			Length aperture ÷ length shell, proportions
			Length	Width	Proportions	Length	Width	Proportions	
			mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Atimaha, D.	1907	79	16.55–20.75	9.3–11.3	49.5–61.5	8.5–10.5	6.5–8.1	67.5–82.5	46.5–55.5
Atimaha, D.	1919	5	16.55–17.75	9.5–10.5	53.5–61.5	8.5– 9.3	6.3–7.3	71.5–80.5	49.5–53.5
Atimaha, D.	1923	165	15.65–21.05	8.5–11.3	48.5–62.5	7.9–10.3	5.7–7.7	68.5–82.5	45.5–58.5
Paahonu, D.	1919	36	17.45–20.15	10.1–11.5	54.5–60.5	8.9–10.9	6.9–8.1	70.5–80.5	49.5–55.5
Vaianai, D.	1907	213	16.55–21.05	9.1–11.7	49.5–60.5	8.5–10.7	6.3–8.1	68.5–81.5	47.5–56.5
Vaianai, D.	1919	32	16.85–20.45	9.5–11.5	49.5–59.5	8.5–10.5	6.5–8.1	70.5–81.5	46.5–53.5
Vaianai, D.	1923	94	16.85–21.05	9.5–11.5	50.5–64.5	8.5–10.7	6.5–8.1	67.5–82.5	46.5–55.5
Oio, D.	1919	472	16.85–21.95	9.5–12.1	50.5–62.5	8.9–11.1	6.5–8.7	69.5–83.5	45.5–56.5
Oio, S.	1919	4	17.45–18.95	10.1–10.9	56.5–62.5	9.1– 9.5	6.9–7.3	75.5–78.5	49.5–52.5
Oio, D.	1923	142	17.45–21.35	10.3–12.1	51.5–60.5	8.9–10.9	6.7–8.3	70.5–84.5	46.5–53.5
Haapiti, D.	1907	190	17.15–21.65	9.5–11.7	49.5–60.5	8.7–10.9	6.5–8.5	70.5–83.5	45.5–53.5
Haapiti, S.	1907	17	16.85–19.85	9.9–11.5	55.5–61.5	8.5–10.1	6.7–7.7	71.5–82.5	47.5–52.5
Haapiti, D.	1923	225	17.15–21.35	9.3–12.1	50.5–62.5	8.1–10.7	6.3–8.3	69.5–82.5	43.5–54.5
Uufau, D.	1907	27	17.15–21.65	9.7–11.5	49.5–57.5	9.1–10.9	6.7–8.3	68.5–78.5	47.5–53.5
Uufau, S.	1907	192	16.55–21.35	9.5–12.1	50.5–62.5	8.7–11.3	6.7–8.7	70.5–82.5	47.5–56.5
Uufau, D.	1923	131	16.55–20.75	9.5–11.7	49.5–62.5	8.7–10.7	6.5–8.3	71.5–85.5	46.5–56.5
Uufau, S.	1923	320	16.25–20.45	9.3–11.5	50.5–62.5	8.5–10.9	6.5–8.3	71.5–84.5	46.5–58.5
Moruu, S.	1909	109	16.55–20.45	9.5–11.5	52.5–63.5	8.5–11.1	6.5–8.1	71.5–82.5	47.5–55.5
Moruu, D.	1923	1	18.35	10.1	54.5	9.1	7.1	76.5	50.5
Moruu, S.	1923	374	15.95–20.45	9.1–11.3	51.5–63.5	8.1–10.3	6.3–8.1	70.5–85.5	44.5–58.5
Varari, S.	1909	196	16.25–20.45	9.3–11.3	48.5–59.5	8.5–10.5	6.3–8.5	69.5–81.5	46.5–56.5
Varari, S.	1923	328	16.55–20.75	9.1–11.3	50.5–64.5	8.1–10.3	6.3–8.1	69.5–85.5	46.5–56.5
Maraarii, S.	1907	296	16.85–21.05	9.3–11.5	49.5–60.5	8.5–11.1	6.3–8.3	68.5–84.5	46.5–55.5
Maraarii, S.	1923	364	16.55–21.65	8.9–11.7	46.5–59.5	8.5–11.1	6.3–8.5	68.5–83.5	43.5–58.5
Maatepua, S.	1924	6	17.15–20.15	10.3–11.9	57.5–60.5	8.5–10.7	6.9–8.3	74.5–80.5	49.5–55.5
Taapurau, S.	1923	35	17.45–21.95	9.9–11.3	49.5–57.5	9.5–11.3	7.1–8.5	70.5–82.5	48.5–53.5
Taapurau, S.	1924	112	18.05–21.65	9.7–11.7	49.5–60.5	9.1–11.3	6.7–8.7	70.5–82.5	47.5–56.5
Pafatu, S.	1907	1	20.15	11.1	55.5	10.5	7.9	75.5	52.5
Pafatu, S.	1919	8	18.95–21.65	10.3–11.5	50.5–56.5	9.9–11.1	7.3–8.5	71.5–78.5	49.5–51.5
Summary:									
All D.	....	1,812	15.65–21.95	8.5–12.1	48.5–64.5	7.9–11.1	5.7–8.7	67.5–85.5	43.5–58.5
All S.	....	2,362	15.95–21.95	8.9–12.1	46.5–64.5	8.1–11.3	6.3–8.7	68.5–85.5	43.5–58.5
Whole series	....	4,174	15.65–21.95	8.5–12.1	46.5–64.5	7.9–11.3	5.7–8.7	67.5–85.5	43.5–58.5

TABLE 75—*Partula suturalis vexillum. Atimaha to Pafatu Valleys. Statistical description*—Continued

Series	Year	No.	Mean value							
			Shell			Aperture			Length aperture ÷length shell, proportions
			Length	Width	Proportions	Length	Width	Proportions	
			mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Atimaha, D.	1907	79	18.6158±0.0628	10.4848±0.0317	56.2975±0.1840	9.5557±0.0329	7.2696±0.0273	75.9684±0.2027	51.2089±0.1388
Atimaha, D.	1919	5	17.0900± .1200	10.0200± .1242	59.3000± .7725	8.9000± .0853	6.8200± .1242	76.5000± .9149	51.7000± .4433
Atimaha, D.	1923	165	18.1918± .0493	10.1812± .0235	55.9243± .1191	9.2346± .0243	6.9860± .0190	75.6333± .1258	50.7485± .1117
Paahonu, D.	1919	36	18.8166± .0735	10.7178± .0411	57.3111± .1792	9.8223± .0489	7.4500± .0292	76.1111± .2679	52.5278± .1768
Vaianai, D.	1907	213	18.7204± .0374	10.3404± .0203	55.1855± .0953	9.5432± .0232	7.1582± .0167	75.0258± .1089	50.8287± .0816
Vaianai, D.	1919	32	18.4156± .0986	10.2563± .0464	55.5937± .2786	9.3125± .0549	7.0938± .0370	76.0625± .2719	50.4063± .2553
Vaianai, D.	1923	94	18.9287± .0621	10.6234± .0283	56.4043± .1649	9.6404± .0282	7.3042± .0222	75.4894± .1738	51.1383± .1275
Oio, D.	1919	472	19.4388± .0268	10.7720± .0138	55.3538± .0578	9.9114± .0145	7.5716± .0128	76.3835± .0701	50.8474± .0576
Oio, S.	1919	4	18.0500± .1892	10.5500± .0997	58.2500± .8389	9.3000± .0477	7.1500± .0559	77.0000± .3770	51.0000± .3770
Oio, D.	1923	142	19.3662± .0479	10.9225± .0197	56.3873± .1144	9.8141± .0228	7.5281± .0179	76.0352± .1305	50.6267± .0930
Haapiti, D.	1907	190	19.0842± .0382	10.5189± .0182	55.0895± .0965	9.6000± .0200	7.3484± .0165	76.4432± .1177	50.2158± .0780
Haapiti, S.	1907	17	18.6147± .1193	10.8177± .0584	58.1471± .2442	9.3941± .0702	7.3706± .0462	78.5000± .4593	50.6176± .2236
Haapiti, D.	1923	225	19.0696± .0394	10.6316± .0199	55.6689± .0889	9.4680± .0219	7.2218± .0166	76.2245± .1154	49.5489± .0833
Uufau, D.	1907	27	19.3833± .1361	10.4333± .0620	53.7592± .2947	9.9741± .0624	7.4852± .0542	75.0555± .3794	51.2778± .2100
Uufau, S.	1907	192	19.0953± .0414	10.6927± .0219	55.8958± .1034	9.8844± .0227	7.5833± .0181	76.5364± .1163	51.7396± .0848
Uufau, D.	1923	131	18.7492± .0469	10.5626± .0260	56.1870± .1300	9.5870± .0251	7.3397± .0197	76.5458± .1425	50.9275± .1133
Uufau, S.	1923	320	18.5094± .0309	10.4094± .0140	56.1906± .0825	9.6037± .0159	7.4613± .0120	77.6844± .0931	51.8281± .0677
Moruu, S.	1909	109	18.4436± .0587	10.4890± .0285	56.8027± .1458	9.5257± .0312	7.3055± .0233	76.6559± .1602	51.5275± .1059
Moruu, D[1]	1923	1	18.35	10.10	54.5	9.10	7.10	76.5	50.5
Moruu, S.	1923	374	17.8928± .0270	10.1347± .0137	56.5401± .0683	9.2021± .0149	7.1519± .0110	77.6658± .0819	51.3636± .0597
Varari, S.	1909	196	18.5429± .0331	10.2919± .0171	55.3470± .1004	9.3877± .0182	7.1857± .0167	76.4898± .1103	50.5255± .0851
Varari, S.	1923	328	18.2979± .0262	10.1823± .0138	55.5975± .0800	9.3232± .0140	7.1439± .0116	76.5945± .0879	50.8384± .0689
Maraarii, S.	1907	296	18.7290± .0285	10.4879± .0150	55.9257± .0805	9.5155± .0153	7.2926± .0126	76.5135± .0903	50.6892± .0754
Maraarii, S.	1923	364	18.8618± .0296	10.2742± .0156	54.3681± .0747	9.7154± .0160	7.3632± .0130	75.7143± .0882	51.4668± .0611
Maatepua, S.	1924	6	19.1500± .1684	11.2666± .1401	59.3333± .2938	10.1333± .2070	7.8666± .1327	78.1666± .5877	52.1666± .6088
Taapurau, S.	1923	35	19.6615± .0984	10.6143± .0390	54.0143± .2203	10.1286± .0520	7.6714± .0382	75.8428± .2467	51.4143± .1597
Taapurau, S.	1924	112	19.7188± .0516	10.7911± .0270	54.6696± .1335	10.1857± .0291	7.7232± .0262	75.6339± .1644	51.6428± .1164
Pafatu, S[1]	1907	1	20.15	11.10	55.5	10.50	7.90	75.5	52.5
Pafatu, S.	1919	8	20.4500± .2055	10.8750± .0906	52.7500± .4257	10.4000± .0954	7.7750± .0922	75.1250± .5954	50.7500± .1577
Summary:									
All D.		1,812	18.9973± .0149	10.5824± .0075	55.6617± .0347	9.6435± .0079	7.3185± .0067	76.0337± .0388	50.6601± .0304
All S.		2,362	18.5949± .0127	10.3688± .0062	55.6939± .0314	9.5471± .0070	7.3286± .0053	76.7117± .0349	51.2582± .0254
Whole series.		4,174	18.7696± .0099	10.4616± .0049	55.6799± .0232	9.5889± .0053	7.3242± .0042	76.4150± .0262	51.9986± .0198

[1] Class values.

TABLE 76—*Partula suturalis vexillum. Atimaha to Pafatu Valleys. Statistical description*—Continued

Series	Year	No.	Standard deviation							
			Shell			Aperture			Length aperture ÷length shell, proportions
			Length	Width	Proportions	Length	Width	Proportions	
			mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Atimaha, D	1907	79	0.8281±0.0444	0.4183±0.0224	2.4255±0.1301	0.4339±0.0232	0.3601±0.0193	2.6711±0.1433	1.8291±0.0981
Atimaha, D	1919	5	.3980± .0848	.4118± .0878	2.5162± .5462	.2828± .0603	.4118± .0878	3.0331± .6469	1.4697± .3134
Atimaha, D	1923	165	.9397± .0348	.4485± .0166	2.2678± .0842	.4641± .0172	.3613± .0134	2.3968± .0889	2.1274± .0790
Paahonu, D	1919	36	.6536± .0520	.3656± .0290	1.5947± .1267	.4353± .0346	.2598± .0206	2.3837± .1894	1.5728± .1250
Vaianai, D	1907	213	.8104± .0264	.4399± .0143	2.0624± .0674	.5016± .0164	.3610± .0118	2.3568± .0770	1.7670± .0577
Vaianai, D	1919	32	.8274± .0697	.3897± .0328	2.3366± .1970	.4608± .0388	.3102± .0262	2.2904± .1922	2.1412± .1805
Vaianai, D	1923	94	.8929± .0439	.4075± .0200	2.3703± .1166	.4051± .0199	.3195± .0157	2.4989± .1229	1.8326± .0901
Oio, D	1919	472	.8615± .0189	.4462± .0097	1.8600± .0409	.4679± .0102	.3818± .0090	2.2580± .0495	1.8532± .0407
Oio, S	1919	4	.5612± .1338	.2958± .0705	2.4875± .5932	.1414± .0337	.1658± .0395	1.1180± .2666	1.1180± .2666
Oio, D	1923	142	.8473± .0339	.3481± .0139	2.0213± .0809	.4031± .0161	.3172± .0126	2.3063± .0923	1.6439± .0657
Haapiti, D	1907	190	.7814± .0270	.3728± .0128	1.9735± .0682	.4098± .0141	.3381± .0116	2.4048± .0832	1.5938± .0551
Haapiti, S	1907	17	.7292± .0843	.3569± .0413	1.4928± .1727	.4290± .0496	.2823± .0326	2.8076± .3248	1.3669± .1581
Haapiti, D	1923	225	.8768± .0278	.4423± .0141	1.9771± .0628	.4881± .0155	.3703± .0117	2.5676± .0816	1.8528± .0589
Uufau, D	1907	27	1.0483± .0962	.4776± .0438	2.2705± .2084	.4812± .0441	.4178± .0383	2.9229± .2683	1.6178± .1485
Uufau, S	1907	192	.8513± .0293	.4505± .0155	2.1237± .0731	.4668± .0160	.3716± .0128	2.3900± .0822	1.7365± .0599
Uufau, D	1923	131	.7962± .0331	.4407± .0184	2.2071± .0919	.4260± .0177	.3338± .0139	2.4179± .1007	1.9223± .0801
Uufau, S	1923	320	.8198± .0218	.3720± .0099	2.1897± .0583	.4216± .0112	.3201± .0085	2.4699± .0658	1.7963± .0479
Moruu, S	1909	109	.9084± .0415	.4409± .0281	2.2565± .1031	.4832± .0220	.3609± .0165	2.4800± .1133	1.6393± .0749
Moruu, D	1923	1	.....	.....	.....	.....	.....	.....	.....
Moruu, S	1923	374	.7736± .0191	.3929± .0097	1.9584± .0483	.4277± .0105	.3174± .0077	2.3490± .0579	1.7135± .0422
Varari, S	1909	196	.6880± .0234	.3556± .0121	2.0842± .0710	.3775± .0128	.3464± .0118	2.2901± .0780	1.7662± .0602
Varari, S	1923	328	.7037± .0185	.3711± .0097	2.1477± .0565	.3757± .0099	.3112± .0082	2.3615± .0621	1.8507± .0487
Maraarii, S	1907	296	.7281± .0201	.3832± .0106	2.0536± .0569	.3903± .0108	.3214± .0089	2.3030± .0638	1.9237± .0533
Maraarii, S	1923	364	.8367± .0209	.4419± .0110	2.1133± .0528	.4543± .0113	.3680± .0092	2.4957± .0623	1.7293± .0432
Maatepua, S	1924	6	.9747± .1898	.5088± .0990	1.0672± .2077	.7520± .1464	.4819± .0938	2.1344± .4155	2.2111± .4305
Taapurau, S	1923	35	.8636± .0696	.3424± .0276	1.9327± .1558	.4564± .0367	.3351± .0270	2.1639± .1744	1.4013± .1129
Taapurau, S	1924	112	.8095± .0365	.4242± .0191	2.0954± .0944	.4572± .0206	.4112± .0185	2.5791± .1162	1.8266± .0823
Pafatu, S	1907	1	.....	.....	.....	.....	.....	.....	.....
Pafatu, S	1919	8	.8617± .1453	.3799± .0640	1.7853± .3010	.4000± .0674	.3865± .0652	2.4968± .4210	0.6614± .1115
Summary:									
All D	.....	1,812	.9398± .0105	.4751± .0053	2.1914± .0245	.5027± .0056	.4223± .0047	2.4499± .0274	1.9208± .0215
All S	.....	2,362	.9136± .0090	.4483± .0044	2.2539± .0222	.5019± .0049	.3820± .0037	2.5129± .0247	1.8319± .0180
Whole series	.....	4,714	.9463± .0070	.4722± .0035	2.2270± .0164	.5045± .0037	.4000± .0029	2.5083± .0185	1.8944± .0140

TABLE 77—*Partula suturalis vexillum. Maramu to Faatoai Valleys. Statistical description*

Series	Year	No.	Range (class values)						
			Shell			Aperture			Length aperture ÷ length shell, proportions
			Length	Width	Proportions	Length	Width	Proportions	
			mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Maramu, D	1919	82	18.95–22.85	10.3–12.1	48.5–58.5	9.3–11.7	7.1–8.7	69.5–81.5	45.5–57.5
Maramu, D	1923	24	18.95–22.55	10.7–12.5	49.5–59.5	9.3–11.7	7.1–8.3	68.5–80.5	44.5–52.5
Maramu, D	1924	57	17.75–22.55	10.1–11.9	50.5–59.5	9.1–11.5	6.9–8.5	69.5–80.5	45.5–54.5
Mouaroa, D	1924	79	18.65–22.85	10.5–12.7	50.5–60.5	9.5–11.7	7.1–9.1	68.5–80.5	47.5–55.5
Faataofe, D	1923	154	18.05–22.85	9.7–12.1	49.5–60.5	9.1–11.3	6.9–8.7	69.5–84.5	45.5–56.5
Faataofe, D	1924	191	18.05–22.05	9.9–12.5	49.5–60.5	9.1–11.7	6.9–8.9	66.5–83.5	44.5–54.5
Fanautaata, D	1923	165	17.75–21.95	9.9–12.1	48.5–59.5	9.1–11.1	6.5–8.5	70.5–81.5	44.5–52.5
Roroie, D	1923	303	17.45–22.25	9.7–12.1	50.5–59.5	8.7–10.9	6.5–8.5	70.5–86.5	43.5–55.5
Morioahu east, D	1923	71	17.75–20.75	10.1–11.9	50.5–61.5	8.5–10.9	6.9–8.3	72.5–84.5	43.5–54.5
Morioahu east, S	1923	100	17.15–21.35	9.7–12.1	52.5–62.5	8.5–11.5	6.7–8.5	72.5–88.5	47.5–56.5
Morioahu, D	1923	99	17.45–21.05	9.7–12.1	50.5–60.5	8.7–10.7	6.9–8.3	71.5–84.5	46.5–56.5
Morioahu, S	1923	305	16.85–21.65	9.7–12.1	50.5–64.5	8.5–10.9	6.7–8.9	68.5–86.5	45.5–55.5
Opunohu west, D	1907	4	18.35–19.55	9.9–10.5	51.5–54.5	9.3– 9.7	6.7–7.3	72.5–75.5	49.5–50.5
Opunohu west, S	1907	122	17.75–22.65	9.9–12.1	49.5–59.5	9.1–10.9	6.7–8.5	70.5–83.5	46.5–54.5
Opunohu west, S	1909	79	17.45–21.35	9.3–11.9	49.5–59.5	8.1–10.9	6.1–8.7	70.5–80.5	45.5–53.5
Opunohu west, below pass, D	1919	7	18.05–21.05	10.3–11.9	53.5–60.5	9.5–10.7	7.3–8.5	76.5–81.5	48.5–54.5
Opunohu west, below pass, S	1919	68	17.45–21.65	10.1–12.1	52.5–61.5	9.1–11.1	7.1–8.9	73.5–83.5	48.5–56.5
Opunohu west, below pass, D	1923	3	18.35–19.25	10.5–11.1	54.5–60.5	9.3–10.1	7.5–8.1	77.5–81.5	50.5–54.5
Opunohu west, below pass, S	1923	177	16.85–21.65	9.3–11.5	50.5–59.5	8.5–10.9	6.5–8.5	71.5–81.5	47.5–56.5
Opunohu west, below Atiati, D	1923	1	18.95	10.7	56.5	10.1	7.5	74.5	53.5
Opunohu west, below Atiati, S	1923	353	15.95–21.05	9.1–11.7	49.5–60.5	8.3–11.3	6.3–8.5	70.5–81.5	45.5–57.5
Opunohu west, Vairahi, S	1924	147	17.15–21.65	9.1–11.5	46.5–60.5	8.5–11.1	6.3–8.3	69.5–81.5	44.5–56.5
Tupuna, S	1923	164	17.15–23.15	9.7–11.9	49.5–58.5	8.5–11.3	7.1–8.5	69.5–83.5	45.5–55.5
Vaiana, D	1923	1	20.15	10.1	50.5	9.9	7.1	71.5	49.5
Vaiana, S	1923	66	18.35–23.15	9.9–12.3	47.5–58.5	9.5–11.3	6.7–8.7	70.5–81.5	45.5–54.5
Aareo, S	1909	1	19.25	10.7	54.5	9.5	6.7	71.5	48.5
Aareo, S	1919	7	19.25–20.45	10.5–10.7	52.5–54.5	9.7–10.3	7.5–7.7	73.5–76.5	49.5–50.5
Aareo, S	1923	9	19.25–21.35	10.1–11.3	50.5–55.5	9.5–10.7	6.9–7.9	70.5–77.5	48.5–50.5
Urufara, S	1907	7	18.95–21.05	10.5–11.9	53.5–56.5	9.9–10.9	7.3–8.7	72.5–79.5	49.5–54.5
Urufara, S	1909	13	18.35–21.65	10.5–11.7	51.5–58.5	9.7–11.1	7.1–8.3	72.5–82.5	44.5–57.5
Urufara south (A), S	1923	10	18.65–21.05	9.9–11.5	51.5–58.5	9.3–10.9	6.9–8.5	73.5–80.5	46.5–52.5
Urufara south (B), S	1923	1	24.95	11.9	47.5	11.3	8.3	72.5	45.5
Urufara south (C), S	1923	44	18.05–21.65	9.9–11.9	50.5–58.5	9.1–11.7	6.9–8.7	72.5–86.5	47.5–55.5
Urufara north central, S	1924	49	19.25–23.15	10.5–12.9	47.5–59.5	9.9–12.1	7.5–8.9	70.5–80.5	45.5–55.5
Faatoai, S	1909	10	20.45–21.65	10.9–12.3	53.5–57.5	10.3–11.3	7.9–8.7	74.5–79.5	49.5–53.5
Faatoai, S	1919	32	19.85–23.15	10.7–12.1	50.5–59.5	9.7–11.7	7.3–8.7	69.5–83.5	45.5–54.5
Faatoai, Mave, S	1923 / 1924	22	18.65–22.25	10.1–11.5	51.5–56.5	9.3–10.5	6.7–8.5	69.5–81.5	47.5–52.5
Faatoai, upper Mave, S	1923	8	19.55–22.85	10.3–11.9	49.5–56.5	9.9–11.3	7.3–8.7	74.5–78.5	47.5–52.5
Faatoai, Taatuapæ, S	1923	16	18.05–21.35	9.7–10.9	51.5–59.5	8.7–10.9	6.7–8.1	70.5–80.5	47.5–52.5
Faatoai, Vaipapa, S	1924	13	18.65–21.65	10.3–11.7	49.5–56.5	9.7–11.1	7.3–8.5	71.5–79.5	48.5–53.5
Faatoai, Terahimaue, S	1923	5	20.75–21.05	11.1–11.9	52.5–54.5	10.3–10.9	8.1–8.5	75.5–79.5	48.5–51.5
Faatoai, Mataitau, S	1923	5	19.85–21.35	9.9–11.7	50.5–54.5	9.3–10.7	7.1–8.5	75.5–78.5	46.5–51.5
Summary:									
Maramu—Roroie, D		1,055	17.45–22.85	9.7–12.7	48.5–60.5	8.7–11.7	6.5–9.1	66.5–86.5	43.5–57.5
Morioahu east—Vaiana, D		186	17.45–21.05	9.7–12.1	50.5–61.5	8.5–10.9	6.9–8.5	70.5–84.5	43.5–56.5
Morioahu east—Vaiana, S		1,581	15.95–23.15	9.1–12.3	46.5–64.5	8.1–11.5	6.1–8.9	68.5–88.5	44.5–57.5
Aareo—Faatoai, S		249	18.05–24.95	9.7–12.9	47.5–59.5	8.7–12.1	6.7–8.9	69.5–86.5	44.5–57.5
Whole series		3,071	15.95–24.95	9.1–12.9	46.5–64.5	8.1–12.1	6.1–9.1	66.5–88.5	43.5–57.5

TABLE 78—*Partula suturalis vexillum. Maramu to Faatoai Valleys. Statistical description*—Continued

Series	Year	No.	Mean value									
			Shell			Aperture			Length aperture ÷ length shell, proportions			
			Length	Width	Proportions	Length	Width	Proportions				
			mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*			
Maramu, D	1919	82	20.5707±0.0599	11.1244±0.0333	54.1463±0.1575	10.3488±0.0369	7.6049±0.0302	75.3293±0.1929	50.2683±0.1408			
Maramu, D	1923	24	20.4625± .1140	11.2166± .0589	54.8333± .2596	10.3416± .0719	7.8333± .0475	75.1250± .4295	50.5416± .2650			
Maramu, D	1924	57	20.2921± .0776	11.0123± .0401	54.3421± .1745	10.2895± .0493	7.6544± .0357	74.2193± .2218	50.7281± .1707			
Mauaroa, D	1924	79	20.7120± .0592	11.4468± .0330	55.2015± .1423	10.6848± .0363	7.9076± .0268	74.0316± .1673	51.4747± .1289			
Faataofe, D	1923	154	20.2941± .0441	11.0468± .0224	54.3507± .1037	10.1961± .0252	7.7623± .0182	76.1169± .1349	50.2403± .1061			
Faataofe, D	1924	191	20.3840± .0385	11.2026± .0229	54.8194± .1016	10.2801± .0225	7.7764± .0191	75.5576± .1279	50.2845± .0910			
Tanautaata, D	1923	165	20.3536± .0399	11.0418± .0212	54.2091± .0950	9.9739± .0220	7.5848± .0187	76.1242± .1186	48.9292± .0896			
Roroie, D	1923	303	19.7028± .0313	10.9528± .0174	55.3317± .0701	9.8333± .0172	7.4888± .0131	76.1666± .0925	49.7013± .0703			
Morioahu east, D	1923	71	19.3260± .0545	10.9366± .0303	56.4718± .1578	9.7084± .0376	7.5366± .0259	77.7394± .1907	50.0775± .1777			
Morioahu east, S	1923	100	19.3280± .0617	10.9300± .0309	56.4800± .1016	9.8820± .0353	7.7240± .0267	77.8400± .1309	50.7700± .1219			
Morioahu, D	1923	99	19.5833± .0663	10.9141± .0319	55.6414± .1379	9.9061± .0297	7.6637± .0234	77.2677± .1600	50.5505± .1254			
Morioahu, S	1923	305	19.2244± .0339	10.7806± .0154	56.0377± .0835	9.8075± .0177	7.6994± .0143	78.4541± .0956	50.9492± .0713			
Opunohu west, D	1907	4	19.0250± .1496	10.2000± .0754	53.5000± .4130	9.5000± .0477	7.0500± .0735	74.0000± .3770	50.0000± .1686			
Opunohu west, S	1907	122	19.6016± .0462	10.9197± .0259	55.6147± .1209	9.9705± .0261	7.5803± .0211	76.0492± .1490	50.7295± .1083			
Opunohu west, S	1909	79	19.5942± .0656	10.7177± .0400	54.7024± .1622	9.8240± .0417	7.4241± .0345	75.5633± .1876	50.0443± .1293			
Opunohu west, below pass, D	1919	7	19.6786± .2448	11.2143± .1214	56.9285± .5595	10.1857± .0898	7.8429± .0892	79.0714± .5072	51.5000± .5940			
Opunohu west, below pass, S	1919	68	19.6470± .0574	11.0412± .0367	56.1618± .1681	10.2294± .0336	7.9706± .0287	77.7088± .1894	52.0147± .1454			
Opunohu west, below pass, D	1923	3	18.6500± .1652	10.7666± .1990	57.8333± .9713	9.7000± .1256	7.7000± .1101	79.8333± .6619	51.8333± .7343			
Opunohu west, below pass, S	1923	177	18.7805± .0369	10.3723± .0215	55.1949± .0938	9.6039± .0224	7.3655± .0176	76.6808± .1087	51.0763± .0886			
Opunohu west, below Atiati, D[1]	1923	1	18.95	10.70	56.50	10.10	7.50	74.50	53 50			
Opunohu west, below Atiati, S	1923	353	19.2984± .0446	10.5944± .0201	54.9223± .1122	9.9745± .0241	7.6645± .0189	76.8292± .1283	51.5994± .1030			
Opunohu west, Vairahi, S	1924	147	19.4765± .0506	10.5218± .0254	54.0442± .1271	9.7449± .0274	7.4306± .0241	76.1326± .1362	50.0306± .1121			
Tupuna, S	1923	164	19.9415± .0449	10.6207± .0211	53.1525± .0998	10.0342± .0242	7.5463± .0190	75.2561± .1422	50.2250± .0888			
Vaiana, D[1]	1923	1	20.15	10.10	50.50	9.90	7.10	71.50	49 50			
Vaiana, S	1923	66	20.5591± .0710	11.0242± .0363	53.6060± .1939	10.2666± .0325	7.7424± .0254	75.1818± .1981	49.9242± .1557			
Aareo, S[1]	1909	1	19.25	10.70	54.50	9.50	6.70	71.50	48 50			
Aareo, S	1919	2	19.8500± .2861	10.6000± .0477	53.5000± .4769	10.0000± .1431	7.5000± .0954	75.0000± .7154	50.0000± .2384			
Aareo, S	1923	9	20.3833± .1645	10.7444± .0893	52.8333± .4105	10.1000± .0734	7.5000± .0636	74.5000± .4740	49.5000± .1836			
Urufara, S	1907	7	20.1072± .2020	11.0429± .1270	54.7857± .2626	10.3571± .0892	7.8429± .1045	75.6428± .5689	51.3572± .3714			
Urufara, S	1909	13	20.3900± .1729	11.0600± .0651	54.2333± .3510	10.2866± .0757	7.7533± .0642	75.6333± .4580	50.4333± .4693			
Urufara south, (A), S	1923	10	20.0600± .2084	10.7800± .1099	53.7000± .4136	10.1000± .0954	7.6400± .0935	75.9000± .4179	50.2000± .3446			
Urufara south, (B), S[1]	1923	1	24.95	11.90	47.50	11.30	8.30	72 50	45 50			
Urufara south, (C), S	1923	44	20.1432± .0841	10.9682± .0456	54.2955± .1834	10.2000± .0556	7.7591± .0432	76.0227± .2569	50.5000± .1939			
Urufara north central, S	1924	49	21.0990± .0840	11.3612± .0483	53.7449± .2046	10.7326± .0399	8.2306± .0329	76.6225± .2233	50.7857± .1763			
Faatoai, S	1909	10	20.9900± .0896	11.6800± .0819	55.1000± .2731	10.7400± .0805	8.3200± .0571	77.0000± .3199	51.0000± .2740			
Faatoai, S	1919	32	20.8906± .0898	11.3750± .0445	54.3875± .2543	10.6312± .0551	8.1250± .0420	76.3750± .3586	50.9687± .2601			
Faatoai, Mave, S	1923 1924	22	20.1091± .1215	10.9182± .0647	53.8182± .2097	10.0272± .0559	7.6818± .0612	76.4091± .4042	49.9091± .2196			
Faatoai, upper Mave, S	1923	8	20.7125± .2396	11.0000± .1092	52.6250± .5894	10.3750± .0952	7.9750± .0890	76.8750± .3359	49.8750± .3759			
Faatoai, Taatuapæ, S	1923	16	19.3250± .1491	10.4250± .0694	54.1875± .3357	9.6375± .0921	7.2875± .0700	75.6250± .5261	49.7500± .3010			
Faatoai, Vaipapa, S	1924	13	20.6577± .1364	11.1307± .0746	53.8077± .4257	10.4230± .0743	7.9615± .0594	76.4231± .4609	50.3462± .3185			
Faatoai, Terahimaue, S	1923	5	20.8700± .0443	11.4800± .0851	54.3000± .4001	10.6200± .0818	8.2200± .0482	77.1000± .2413	50.3000± .3518			
Faatoai, Mataitau, S	1923	5	20.4500± .1717	10.9000± .1830	53.1000± .4514	9.9200± .1407	7.8200± .1367	76.9000± .5259	49.7000± .5189			
Summary:												
Maramu—Roroie, D		1,055	20.2372± .0180	11.0852± .0095	54.7550± .0411	10.1292± .0109	7.6678± .0080	75.6886± .0528	50.0157± .0404			
Morioahu east—Vaiana, D		186	19.4613± .0406	10.9107± .0222	55.8731± .1063	9.8301± .0226	7.6086± .0178	77.4409± .1219	50.4247± .0988			
Morioahu east—Vaiana, S		1,581	19.3294± .0163	10.6445± .0083	55.0022± .0392	9.8355± .0086	7.5538± .0070	76.7656± .0452	50.8049± .0321			
Aareo—Faatoai, S		249	20.5018± .0420	11.0871± .0229	53.9860± .0860	10.3578± .0236	7.8960± .0202	76.2028± .1108	50.4277± .0817			
Whole series		3,071	19.7495± .0126	10.8479± .0064	54.8937± .0268	9.9784± .0066	7.6240± .0051	76.3909± .0324	50.4801± .0237			

[1] Class values.

TABLE 79—*Partula suturalis vexillum. Maramu to Faatoai Valleys. Statistical description*—Continued

Standard deviation

Series	Year	No.	Shell			Aperture			Length aperture÷length shell, proportions
			Length	Width	Proportions	Length	Width	Proportions	
			mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Maramu, D	1919	82	0.8045±0.0423	0.4496±0.0235	2.1148±0.1114	0.4954±0.0261	0.4051±0.0213	2.5899±0.1364	1.8889±0.0995
Maramu, D	1923	24	.8283± .0806	.4279± .0416	1.8856± .1835	.5227± .0508	.3448± .0336	3.1199± .3037	1.9252± .1874
Maramu, D	1924	57	.8689± .0549	.4496± .0283	1.9537± .1234	.5524± .0348	.3996± .0252	2.4833± .1568	1.9104± .1207
Mouaroa, D	1924	79	.7805± .0418	.4348± .0233	1.8755± .1006	.4781± .0258	.3535± .0189	2.2038± .1182	1.6987± .0911
Faataofe, D	1923	154	.8121± .0212	.4122± .0158	1.9082± .0733	.4639± .0178	.3354± .0128	2.4816± .0954	1.9533± .0750
Faataofe, D	1924	191	.7883± .0272	.4697± .0162	2.0819± .0718	.4611± .0159	.3908± .0135	2.6213± .0904	1.8648± .0643
Fanautaata, D	1923	165	.7604± .0282	.4048± .0150	1.8091± .0672	.4202± .0155	.3559± .0132	2.2599± .0838	1.7061± .0633
Roroie, D	1923	303	.8088± .0221	.4499± .0123	1.8098± .0496	.4440± .0121	.3381± .0092	2.3890± .0654	1.8137± .0497
Morioahu east, D	1923	71	.6806± .0385	.3787± .0214	1.9714± .1116	.4705± .0266	.3240± .0183	2.3822± .1348	2.1207± .1256
Morioahu east, S	1923	100	.9145± .0436	.4580± .0218	1.5065± .0718	.5231± .0249	.3961± .0189	1.9505± .0925	1.8075± .0862
Morioahu, D	1923	99	.8892± .0426	.4707± .0225	2.0351± .0975	.4380± .0210	.3462± .0165	2.3604± .1131	1.8498± .0887
Morioahu, S	1923	305	.8785± .0240	.3999± .0109	2.1621± .0590	.4592± .0125	.3695± .0101	2.4797± .0676	1.8458± .0504
Opunohu west, D	1907	4	.4437± .1058	.2236± .0532	1.2247± .2920	.1414± .0337	.2179± .0520	1.1180± .2666	0.5000± .1192
Opunohu west, S	1907	122	.7573± .0326	.4242± .0183	1.9802± .0855	.4276± .0184	.3461± .0149	2.4399± .1053	1.7731± .0766
Opunohu west, S	1909	79	.8645± .0464	.5269± .0283	2.1370± .1147	.5496± .0295	.4548± .0244	2.4718± .1326	1.7047± .0914
Opunohu west, below pass, D	1919	7	.9602± .1731	.4764± .0858	2.1946± .3956	.3522± .0635	.3498± .0631	1.9898± .3586	2.3299± .4200
Opunohu west, below pass, S	1919	68	.7025± .0406	.4486± .0259	2.0552± .1188	.4113± .0237	.3511± .0203	2.3153± .1339	1.7781± .1028
Opunohu west, below pass, D	1923	3	.4242± .1168	.5112± .1407	2.4944± .6868	.3266± .0888	.2828± .0778	1.6997± .4680	1.8856± .5192
Opunohu west, below pass, S	1923	177	.7291± .0261	.4249± .0152	1.8496± .0663	.4420± .0158	.3471± .0124	2.1448± .0768	1.7487± .0626
Opunohu west, below Atiati, D	1923	1							
Opunohu west, below Atiati, S	1923	353	.8398± .0315	.3783± .0142	2.1108± .0793	.4540± .0170	.3561± .0133	2.4133± .0907	1.9376± .0728
Opunohu west, Vairahi, S	1924	147	.9088± .0357	.4560± .0179	2.2804± .0898	.4919± .0193	.4325± .0170	2.4442± .0962	2.0112± .0792
Tupuna, S	1923	164	.8532± .0317	.4009± .0149	1.8954± .0705	.4602± .0171	.3606± .0134	2.7008± .1005	1.6868± .0628
Vaiana, D	1923	1							
Vaiana, S	1923	66	.8559± .0502	.4373± .0256	2.3363± .1371	.3917± .0230	.3065± .0179	2.3878± .1401	1.8754± .1101
Aareo, S	1909	1							
Aareo, S	1919	2	.6000± .2023	.1000± .0337	1.0000± .3372	.3000± .1012	.2000± .0674	1.5000± .5058	0.5000± .1686
Aareo, S	1923	9	.7318± .1163	.3975± .0631	1.8258± .2902	.3266± .0519	.2828± .0450	2.1082± .3351	0.8165± .1298
Urufara, S	1907	7	.7926± .1428	.4982± .0898	1.0301± .1857	.3499± .0631	.4101± .0739	2.2315± .4023	1.4569± .2626
Urufara, S	1909	13	.9932± .1222	.3738± .0460	2.0155± .2482	.4349± .0535	.3685± .0454	2.6299± .3238	2.6948± .3318
Urufara south, (A), S	1923	10	.9772± .1473	.5154± .0777	1.9391± .2924	.4472± .0674	.4386± .0661	1.9596± .2955	1.6155± .2436
Urufara south, (B), S	1923	1							
Urufara south, (C), S	1923	44	.8277± .0594	.4491± .0322	1.8038± .1297	.5469± .0393	.4255± .0305	2.5270± .1816	1.9069± .1371
Urufara north central, S	1924	49	.8722± .0594	.5017± .0341	2.1240± .1447	.4147± .0282	.3418± .0232	2.3179± .1579	1.8295± .1246
Faatoai, S	1909	10	.4200± .0633	.3842± .0579	1.2806± .1931	.3774± .0569	.2676± .0404	1.5000± .2262	1.2845± .1937
Faatoai, S	1919	32	.7537± .0635	.3733± .0314	2.1330± .1798	.4626± .0389	.3527± .0297	3.0078± .2535	2.1815± .1839
Faatoai, Mave, S	1923 1924	22	.8451± .0859	.4499± .0459	1.4581± .1483	.3887± .0395	.4260± .0433	2.8108± .2858	1.5273± .1553
Faatoai, upper Mave, S	1923	8	1.0049± .1694	.4582± .0772	2.4717± .4167	.3992± .0673	.3733± .0629	1.4087± .2375	1.5762± .2658
Faatoai, Taatuapæ, S	1923	16	.8842± .1054	.4115± .0491	1.9912± .2374	.5464± .0651	.4151± .0495	3.1200± .3720	1.7854± .2128
Faatoai, Vaipapa, S	1924	13	.7290± .0964	.3988± .0527	2.2755± .3010	.3974± .0525	.3175± .0420	2.4639± .3259	1.7027± .2252
Faatoai, Terahimaue, S	1923	5	.1469± .0313	.2821± .0602	1.3266± .2829	.2713± .0578	.1600± .0341	0.8000± .1706	1.1662± .2487
Faatoai, Mataitau, S	1923	5	.5692± .1214	.6066± .1294	1.4966± .3192	.4665± .0995	.4534± .0966	1.7435± .3718	1.7204± .3669
Summary:									
Maramu—Roroie, D		1,055	.8660± .0127	.4604± .0067	1.9791± .0290	.5253± .0077	.3869± .0056	2.5456± .0373	1.9480± .0285
Morioahu east—Vaiana, D		186	.8215± .0287	.4495± .0157	2.1504± .0751	.4582± .0160	.3599± .0126	2.4653± .0862	1.9986± .0698
Morioahu east—Vaiana, S		1,581	.9610± .0115	.4919± .0058	2.3106± .0277	.5055± .0061	.4152± .0049	2.6683± .0319	1.8919± .0227
Aareo—Faatoai, S		249	.9823± .0297	.5355± .0162	2.0122± .0608	.5521± .0167	.4740± .0143	2.5928± .0783	1.9124± .0578
Whole series		3,071	1.0358± .0089	.5276± .0045	2.2017± .0189	.5433± .0046	.4188± .0036	2.6678± .0229	1.9528± .0167

TABLE 80—*Partula suturalis vexillum. Tefeo to Paparoa Valleys. Statistical description. All dextral*

Series	Year	No.	Shell						Aperture						Length aperture ÷ length shell, proportions	
			Length		Width		Proportions		Length		Width		Proportions			
			mm.		*mm.*		*p. ct.*		*mm.*		*mm.*		*p. ct.*		*p. ct.*	
Range (class values)																
Tefeo	1923	38	19.55	−23.45	10.3	−12.3	48.5	−56.5	9.5	−11.9	6.9	−8.9	65.5	−78.5	43.5	−53.5
Tefeo east	1923	48	18.95	−24.65	10.3	−12.7	50.5	−57.5	9.9	−11.9	6.9	−9.1	68.5	−78.5	46.5	−53.5
Fareaito	1923	166	18.95	−22.85	9.7	−12.3	48.5	−57.5	9.1	−12.1	6.7	−8.7	67.5	−80.5	43.5	−53.5
Fareaito	1924	29	19.85	−23.45	10.3	−12.1	48.5	−58.5	10.1	−11.3	7.1	−8.7	70.5	−81.5	45.5	−52.5
Irua	1919	6	21.05	−22.25	11.5	−12.3	51.5	−56.5	10.5	−11.3	8.1	−8.5	73.5	−77.5	49.5	−51.5
Irua	1923	38	18.05	−22.55	9.7	−12.1	49.5	−58.5	8.5	−11.3	6.5	−8.5	67.5	−79.5	46.5	−54.5
Ririofau	1924	54	19.25	−24.05	10.5	−12.3	50.5	−59.5	9.9	−11.9	7.1	−8.7	68.5	−82.5	47.5	−56.5
Poua	1919	57	18.65	−22.85	10.3	−12.9	50.5	−59.5	9.7	−12.3	7.3	−9.7	70.5	−81.5	45.5	−54.5
Poua	1923	46	19.85	−22.85	10.7	−12.9	50.5	−60.5	9.9	−11.9	7.3	−9.1	68.5	−80.5	46.5	−54.5
Mouaputa (A)	1919	110	18.65	−22.55	10.1	−12.3	49.5	−58.5	9.3	−11.7	6.9	−8.7	66.5	−79.5	47.5	−55.5
Mouaputa (B)	1919	176	18.65	−23.15	9.9	−12.7	48.5	−61.5	9.1	−11.9	6.7	−8.9	66.5	−84.5	45.5	−57.5
Mouaputa	1923	159	18.05	−24.05	10.1	−12.7	48.5	−60.5	9.1	−11.7	6.9	−8.7	68.5	−82.5	45.5	−56.5
Paparoa	1909	2	20.75	−21.05	11.1	−11.5	52.5	−55.5	11.1	−11.5	8.3	−8.5	71.5	−76.5	53.5	−54.5
Whole series	....	929	18.05	−24.65	9.7	−12.9	48.5	−61.5	8.5	−12.3	6.5	−9.7	65.5	−84.5	43.5	−57.5
Mean value																
Tefeo	1923	38	20.9631	± 0.0996	11.0158	± 0.0480	52.4837	± 0.2209	10.3684	± 0.0539	7.5210	±0.0381	72.8685	± 0.3362	49.3421	± 0.2210
Tefeo east	1923	48	21.3313	± .1023	11.4166	± .0510	53.4583	± .1798	10.7542	± .0473	7.9833	± .0416	74.0625	± .2256	50.3959	± .1629
Fareaito	1923	166	20.8078	± .0454	11.0169	± .0241	52.9458	± .0992	10.2976	± .0256	7.5843	± .0199	73.5663	± .1281	49.4458	± .0974
Fareaito	1924	29	21.3190	± .1131	11.3069	± .0524	53.1207	± .2535	10.6724	± .0525	7.9689	± .0401	74.6379	± .3673	49.9483	± .2059
Irua	1919	6	21.7000	± .1299	11.9666	± .0821	54.1666	± .4402	10.9333	± .0740	8.2666	± .0494	75.5000	± .3894	50.5000	± .2248
Irua	1923	38	20.8647	± .1024	11.1210	± .0578	53.2895	± .1898	10.5158	± .0576	7.7632	± .0479	73.1526	± .2671	50.9210	± .1855
Ririofau	1924	54	21.9833	± .0722	11.4815	± .0386	54.5555	± .1679	10.6889	± .0373	8.1666	± .0313	76.2037	± .2308	50.9074	± .1823
Poua	1919	57	20.7184	± .0851	11.4158	± .0477	55.0439	± .1771	10.5561	± .0441	8.0649	± .0353	76.5175	± .2146	50.7982	± .1569
Poua	1923	46	21.4674	± .0724	11.6783	± .0458	54.3696	± .1896	10.9478	± .0460	8.2087	± .0399	74.8696	± .2913	50.9130	± .1653
Mouaputa (A)	1919	110	20.5836	± .0515	11.1673	± .0315	54.0000	± .1120	10.5454	± .0306	7.8382	± .0237	74.3909	± .1537	51.1364	± .1126
Mouaputa (B)	1919	176	20.7432	± .0446	11.2636	± .0250	54.2727	± .1079	10.5886	± .0242	7.9125	± .0203	74.3125	± .1339	51.0568	± .0999
Mouaputa	1923	159	20.6368	± .0484	11.2253	± .0245	54.3798	± .1137	10.4912	± .0253	7.8050	± .0203	74.2658	± .1366	50.8164	± .0928
Paparoa	1909	2	20.9000	± .0715	11.3000	± .0954	54.0000	± .7154	11.3000	± .0954	8.4000	± .0477	74.0000	± 1.1923	54.0000	± .2384
Whole series	....	929	20.8329	± .0202	11.2416	± .0112	53.8972	± .0463	10.5435	± .0111	7.8535	± .0095	74.4139	± .0600	50.4365	± .0427

TABLE 80—*Partula suturalis vexillum. Tefeo to Paparoa Valleys. Statistical description. All dextral*—Continued

			Standard deviation							
Tefeo	1923	38	0.9102± 0.0704	0.4392± 0.0339	2.0195± 0.1562	0.4925± 0.0381	0.3488±0.0269	3.0729± 0.2377	2.0199± 0.1563
Tefeo east	1923	48	1.0507± .0723	.5241± .0360	1.8477± .1271	.4860± .0334	.4278± .0294	2.3175± .1595	1.6738± .1152
Fareaito	1923	166	.8674± .0321	.4616± .0170	1.8962± .0701	.4894± .0181	.3797± .0141	2.4474± .0906	1.8604± .0689
Fareaito	1924	29	.9029± .0800	.4185± .0370	2.0242± .1792	.4193± .0371	.3207± .0283	2.9329± .2598	1.6442± .1456
Irua	1919	6	.4717± .0918	.2981± .0580	1.5986± .3112	.2687± .0523	.1795± .0349	1.4142± .2753	0.8165± .1589
Irua	1923	38	.9364± .0724	.5287± .0409	1.7344± .1342	.5269± .0407	.4379± .0339	2.4409± .1888	1.6956± .1311
Ririofau	1924	54	.7867± .0510	.4203± .0273	1.8299± .1187	.4063± .0264	.3399± .0220	2.6149± .1632	1.9862± .1289
Poua	1919	57	.9531± .0602	.5337± .0337	1.9830± .1252	.4938± .0312	.3949± .0249	2.4024± .1517	1.7569± .1109
Poua	1923	46	.7281± .0512	.4610± .0324	1.9066± .1340	.4628± .0325	.4015± .0282	2.9293± .2060	1.6626± .1169
Mouaputa (A)	1919	110	.8015± .0364	.4894± .0223	1.7412± .0792	.4769± .0216	.3685± .0167	2.3907± .1087	1.7515± .0796
Mouaputa (B)	1919	176	.8769± .0315	.4922± .0177	2.1229± .0763	.4766± .0171	.4001± .0143	2.6337± .0947	1.9648± .0706
Mouaputa	1923	159	.9051± .0342	.4592± .0173	2.1269± .0804	.4732± .0179	.3790± .0143	2.5536± .0966	1.7360± .0656
Paparoa	1909	2	.1500± .0505	.2000± .0674	1.5000± .5058	.2000± .0674	.1000± .0337	2.5000± .8431	0.5000± .1686
Whole series	....	929	.9117± .0143	.5080± .0079	2.0932± .0327	.5033± .0078	.4293± .0067	2.7101± .0424	1.9324± .0302

TABLE 81—*Partula suturalis vexillum. Vaiare, Tepu, and Maharepa Valleys. Statistical description*

Series	Year	No.	Range (class values)											
			Shell						Aperture					
			Length		Width		Proportions		Length		Width		Proportions	
			mm.		*mm.*		*p. ct.*		*mm.*		*mm.*		*p. ct.*	
Vaiare:														
Puutu, D	1907	30	18.35	−21.05	10.1	−11.9	50.5	−58.5	8.9	−11.3	6.9	−8.5	70.5	−79.5
Puutu, S	1907	10	18.95	−21.35	10.3	−11.9	52.5	−61.5	9.1	−11.1	6.9	−8.5	68.5	−77.5
Puutu, D	1919	91	17.75	−22.25	9.9	−11.5	49.5	−59.5	8.9	−11.1	6.5	−8.3	68.5	−81.5
Puutu, S	1919	41	17.75	−21.35	9.9	−11.9	50.5	−60.5	9.1	−11.3	6.7	−8.7	70.5	−80.5
Vaipohe, D	1919	3	20.45	−22.55	10.9	−11.5	51.5	−54.5	10.7	−10.9	7.9	−8.3	74.5	−76.5
Vaipohe, S	1919	1	21.35		11.9		55.5		11.7		8.7		78.5	
Vaipohe, D	1924	153	18.65	−21.95	9.7	−12.7	50.5	−62.5	9.5	−11.7	6.5	−8.9	67.5	−79.5
Vaipohe, S	1924	2	19.85	−20.15	10.7	−11.3	54.5	−55.5	9.9	−10.7	7.3	−7.7	71.5	−74.5
Faamaariri, D	1919	147	17.75	−21.95	9.7	−12.1	50.5	−59.5	8.9	−11.1	6.7	−8.5	66.5	−79.5
Faamaariri, S	1919	82	17.45	−21.05	9.9	−11.9	50.5	−62.5	9.1	−11.3	6.7	−8.3	68.5	−82.5
Faamaariri (A), D	1923	58	18.65	−22.25	10.1	−11.9	49.5	−59.5	9.3	−11.3	7.1	−8.9	70.5	−81.5
Faamaariri (A), S	1923	49	17.75	−22.25	10.1	−12.3	52.5	−59.5	9.3	−11.3	7.1	−8.7	69.5	−80.5
Faamaariri (B), D	1923	98	17.75	−22.25	9.3	−12.3	49.5	−59.5	9.7	−11.9	7.1	−8.9	68.5	−81.5
Faamaariri (B), S	1923	103	17.75	−22.55	10.3	−12.5	50.5	−61.5	9.1	−12.1	7.1	−9.1	70.5	−83.5
Faamaariri, D	1924	145	17.45	−21.35	9.3	−11.5	48.5	−62.5	8.9	−10.7	6.3	−8.1	68.5	−80.5
Faamaariri, S	1924	20	17.75	−20.75	10.3	−11.7	50.5	−58.5	9.5	−11.1	6.9	−8.3	72.5	−77.5
Tepu, S	1919	13	17.75	−20.45	10.5	−11.5	54.5	−60.5	9.5	−10.5	7.5	−8.3	75.5	−81.5
Maharepa, S	1923	57	17.75	−21.35	9.7	−11.9	49.5	−60.5	9.1	−11.1	6.9	−8.5	69.5	−80.5
Summary:														
All D	....	725	17.45	−22.55	9.3	−12.7	48.5	−62.5	8.9	−11.9	6.3	−8.9	66.5	−81.5
All S	....	378	17.45	−22.55	9.7	−12.5	49.5	−62.5	9.1	−12.1	6.7	−9.1	68.5	−83.5
Whole series	....	1,103	17.45	−22.55	9.3	−12.7	48.5	−62.5	8.9	−12.1	6.3	−9.1	66.5	−83.5

Series	Year	No.	Length aperture ÷ length shell, proportions	
			p. ct.	
Vaiare:				
Puutu, D	1907	30	47.5	−55.5
Puutu, S	1907	10	48.5	−54.5
Puutu, D	1919	91	45.5	−56.5
Puutu, S	1919	41	48.5	−58.5
Vaipohe, D	1919	3	48.5	−53.5
Vaipohe, S	1919	1	54.5	
Vaipohe, D	1924	153	46.5	−55.5
Vaipohe, S	1924	2	49.5	−53.5
Faamaariri, D	1919	147	46.5	−55.5
Faamaariri, S	1919	82	48.5	−60.5
Faamaariri (A), D	1923	58	48.5	−56.5
Faamaariri (A), S	1923	49	47.5	−56.5
Faamaariri (B), D	1923	98	47.5	−58.5
Faamaariri (B), S	1923	103	45.5	−57.5
Faamaariri, D	1924	145	46.5	−56.5
Faamaariri, S	1924	20	47.5	−53.5
Tepu, S	1919	13	48.5	−55.5
Maharepa, S	1923	57	47.5	−54.5
Summary:				
All D	....	725	45.5	−58.5
All S	....	378	45.5	−60.5
Whole series	....	1,103	45.5	−60.5

TABLE 81—*Partula suturalis vexillum. Vaiare, Tepu, and Maharepa Valleys. Statistical description*—Continued

			Mean value											
Vaiare:														
Puutu, D	1907	30	19.7100 ±	0.0796	10.6133 ±	0.0585	53.8000 ±	0.2466	10.2000 ±	0.0632	7.5933 ±	0.0495	74.4333 ±	0.2913	51.6333 ±	0.2173
Puutu, S	1907	10	19.9100 ±	.1514	11.1000 ±	.1079	55.6000 ±	.5837	10.2000 ±	.1210	7.6400 ±	.0973	74.9000 ±	.6413	51.1000 ±	.4494
Puutu, D	1919	91	19.5665 ±	.0579	10.7286 ±	.0270	54.7638 ±	.1467	10.0758 ±	.0306	7.4758 ±	.0215	74.1484 ±	.1665	51.4231 ±	.1395
Puutu, S	1919	41	19.2719 ±	.0963	10.7880 ±	.0395	55.8902 ±	.2472	10.1341 ±	.0492	7.6903 ±	.0372	75.8514 ±	.2379	52.4756 ±	.2237
Vaipohe, D	1919	3	21.3500 ±	.3350	11.3666 ±	.1600	52.5000 ±	.5507	10.8333 ±	.0367	8.1000 ±	.0636	75.1666 ±	.3671	50.5000 ±	.4522
Vaipohe, S[1]	1919	1	21.25		11.90		55.50		11.70		8.70		78.50		54.50	
Vaipohe, D	1924	153	20.3441 ±	.0418	11.1549 ±	.0281	54.7026 ±	.1220	10.4817 ±	.0242	7.7000 ±	.0224	73.3105 ±	.1229	51.4673 ±	.0994
Vaipohe, S	1924	2	20.0000 ±	.0715	11.0000 ±	.1431	55.0000 ±	.2384	10.3000 ±	.1908	7.5000 ±	.0954	73.0000 ±	.7154	51.5000 ±	.9539
Faamaariri, D	1919	147	19.6235 ±	.0469	10.7803 ±	.0242	54.8605 ±	.0984	10.0769 ±	.0260	7.5245 ±	.0206	74.6292 ±	.1422	51.5163 ±	.0960
Faamaariri, S	1919	82	19.2829 ±	.0642	10.5927 ±	.0255	55.0122 ±	.1699	10.1171 ±	.0316	7.5707 ±	.0242	74.9146 ±	.2008	52.4756 ±	.1534
Faamaariri (A), D	1923	58	19.9017 ±	.0745	10.7586 ±	.0329	54.0172 ±	.1982	10.3172 ±	.0369	7.8103 ±	.0302	75.7241 ±	.1960	51.6379 ±	.1493
Faamaariri (A), S	1923	49	19.7643 ±	.0805	11.1449 ±	.0427	56.3572 ±	.1605	10.2388 ±	.0470	7.7612 ±	.0397	75.8061 ±	.2584	51.7857 ±	.1805
Faamaariri (B), D	1923	98	20.0123 ±	.0617	10.9265 ±	.0312	54.5510 ±	.1415	10.4184 ±	.0295	7.8347 ±	.0256	75.2041 ±	.1638	52.0408 ±	.1363
Faamaariri (B), S	1923	103	19.8500 ±	.0584	11.2165 ±	.0289	56.4321 ±	.1500	10.4146 ±	.0347	7.9388 ±	.0262	76.2670 ±	.1907	52.3253 ±	.1403
Faamaariri, D	1924	145	19.2893 ±	.0478	10.4738 ±	.0236	54.3345 ±	.1193	9.8407 ±	.0251	7.2255 ±	.0204	73.4724 ±	.1284	50.9345 ±	.1118
Faamaariri, S	1924	20	19.7150 ±	.1291	10.9900 ±	.0599	55.6000 ±	.2974	10.1000 ±	.0694	7.5500 ±	.0555	75.0000 ±	.2684	51.2500 ±	.2606
Tepu, S	1919	13	19.0423 ±	.1348	10.8539 ±	.0532	56.8848 ±	.3073	10.0385 ±	.0725	7.8231 ±	.0540	77.8846 ±	.3708	52.5769 ±	.3845
Maharepa, S	1923	57	19.5237 ±	.0825	10.7772 ±	.0372	55.1666 ±	.1866	10.0053 ±	.0404	7.5140 ±	.0315	75.2017 ±	.2022	51.3017 ±	.1317
Summary:																
All D	....	725	19.7874 ±	.0226	10.8045 ±	.0125	54.5469 ±	.0526	10.1886 ±	.0127	7.5657 ±	.0106	74.2186 ±	.0623	51.4186 ±	.0476
All S	....	378	19.5841 ±	.0317	10.9323 ±	.0164	55.8042 ±	.0777	10.2027 ±	.0174	7.7121 ±	.0141	75.6481 ±	.0927	52.0555 ±	.0705
Whole series	....	1,103	19.7178 ±	.0115	10.8483 ±	.0100	54.9778 ±	.0453	10.1933 ±	.0102	7.6159 ±	.0086	74.7085 ±	.0536	51.8369 ±	.0400
			Standard deviation											
Vaiare:														
Puutu, D	1907	30	0.6468 ±	0.0563	0.4752 ±	0.0413	2.0025 ±	0.1744	0.5131 ±	0.0447	0.4024 ±	0.0350	2.3655 ±	0.2060	1.7651 ±	0.1536
Puutu, S	1907	10	.7099 ±	.1070	.5059 ±	.0763	2.7368 ±	.4127	.5674 ±	.0855	.4565 ±	.0688	3.0066 ±	.4534	2.1071 ±	.3178
Puutu, D	1919	91	.8096 ±	.0402	.3827 ±	.0191	2.0746 ±	.1037	.4336 ±	.0216	.3050 ±	.0152	2.3551 ±	.1177	1.9736 ±	.0986
Puutu, S	1919	41	.9143 ±	.0681	.3748 ±	.0279	2.3465 ±	.1748	.4673 ±	.0348	.3532 ±	.0263	2.2590 ±	.1682	2.1240 ±	.1582
Vaipohe, D	1919	3	.8602 ±	.2369	.4109 ±	.1131	1.4142 ±	.3894	.0943 ±	.0259	.1633 ±	.0450	0.9428 ±	.2596	2.1602 ±	.3197
Vaipohe, S	1919	1														
Vaipohe, D	1924	153	.7666 ±	.0295	.5160 ±	.0198	2.2386 ±	.0862	.4442 ±	.0171	.4116 ±	.0158	2.2543 ±	.0869	1.8236 ±	.0703
Vaipohe, S	1924	2	.1500 ±	.0505	.3000 ±	.1012	0.5000 ±	.1686	.4000 ±	.1349	.2000 ±	.0674	1.5000 ±	.5058	2.0000 ±	.6745
Faamaariri, D	1919	147	.8432 ±	.0331	.4349 ±	.0171	1.7688 ±	.0696	.4669 ±	.0184	.3702 ±	.0145	2.5562 ±	.1005	1.7262 ±	.0679
Faamaariri, S	1919	82	.8627 ±	.0454	.3424 ±	.0180	2.2806 ±	.1201	.4250 ±	.0223	.3252 ±	.0171	2.6958 ±	.1420	2.0599 ±	.1085
Faamaariri (A), D	1923	58	.8414 ±	.0527	.3714 ±	.0232	2.2379 ±	.1401	.4173 ±	.0261	.3407 ±	.0213	2.2131 ±	.1386	1.6861 ±	.1056
Faamaariri (A), S	1923	49	.8354 ±	.0569	.4431 ±	.0302	1.6660 ±	.1135	.4885 ±	.0332	.4124 ±	.0281	2.6818 ±	.1827	1.8735 ±	.1276
Faamaariri (B), D	1923	98	.9063 ±	.0436	.4577 ±	.0220	2.0769 ±	.1000	.4332 ±	.0208	.3766 ±	.0181	2.4041 ±	.1158	2.0009 ±	.0964
Faamaariri (B), S	1923	103	.8784 ±	.0413	.4358 ±	.0204	2.2566 ±	.1060	.5226 ±	.0245	.3952 ±	.0185	2.8696 ±	.1348	2.1107 ±	.0992
Faamaariri, D	1924	145	.8531 ±	.0338	.4210 ±	.0167	2.1303 ±	.0843	.4488 ±	.0177	.3639 ±	.0144	2.2922 ±	.0908	1.9959 ±	.0790
Faamaariri, S	1924	20	.8563 ±	.0913	.3974 ±	.0423	1.9723 ±	.2103	.4604 ±	.0491	.3681 ±	.0392	1.7464 ±	.1862	1.7282 ±	.1843
Tepu, S	1919	13	.7195 ±	.0952	.2845 ±	.0376	1.6426 ±	.2173	.3874 ±	.0512	.2887 ±	.0382	1.9822 ±	.2622	2.0554 ±	.2719
Maharepa, S	1923	57	.9238 ±	.0583	.4167 ±	.0263	2.0886 ±	.1319	.4528 ±	.0285	.3531 ±	.0223	2.2631 ±	.1430	1.4745 ±	.0931
Summary:																
All D	....	725	.9043 ±	.0160	.5004 ±	.0088	2.0994 ±	.0372	.5066 ±	.0090	.4255 ±	.0075	2.4882 ±	.0440	1.9025 ±	.0336
All S	....	378	.9147 ±	.0224	.4742 ±	.0116	2.2408 ±	.0549	.5027 ±	.0123	.4062 ±	.0100	2.6715 ±	.0655	2.0324 ±	.0498
Whole series	....	1,103	.9130 ±	.0131	.4953 ±	.0071	2.2292 ±	.0320	.5030 ±	.0072	.4248 ±	.0061	2.6411 ±	.0379	1.9713 ±	.0283

[1] Class values.

TABLE 82—*Partula suturalis vexillum. Atimaha to Pafatu Valleys. Statistics of tooth-development*

Series	Year	No.	Index					Average
			1	2	3	4	5	
Atimaha, D	1907	103	4	22	57	16	4	2.9418
Atimaha, D	1919	5	1	3	1	....	....	2.0000
Atimaha, D	1923	174	5	143	19	5	2	2.1724
Paahonu, D	1919	39	1	27	11	....	....	2.2564
Vaianai, D	1907	269	5	50	161	40	13	3.0223
Vaianai, D	1919	37	1	23	10	3	....	2.4054
Vaianai, D	1923	98	1	78	18	1	....	2.1939
Oio, D	1919	604	2	282	265	51	4	2.6242
Oio, S	1919	8	....	4	2	2	....	2.7500
Oio, D	1923	158	2	123	30	1	2	2.2278
Haapiti, D	1907	223	....	21	149	36	17	3.2197
Haapiti, S	1907	18	....	1	13	3	1	3.2222
Haapiti, D	1923	265	1	165	90	8	1	2.4075
Uufau, D	1907	38	....	5	22	8	3	3.2368
Uufau, S	1907	265	1	38	154	56	16	3.1811
Uufau, D	1923	156	....	107	37	8	4	2.4160
Uufau, S	1923	377	5	239	102	24	7	2.4403
Moruu, S	1909	127	1	24	73	24	5	3.0630
Moruu, D	1923	1	....	1	....	....	....	2.0000
Moruu, S	1923	409	4	287	99	13	6	2.3398
Varari, S	1909	227	....	24	135	50	18	3.2721
Varari, S	1923	348	1	239	93	14	1	2.3534
Maraarii, S	1909	389	1	38	212	103	35	3.3419
Maraarii, S	1923	399	5	201	165	21	7	2.5589
Maatepua, S	1924	7	1	6	....	....	....	1.8572
Taapurau, S	1923	36	5	17	11	2	1	2.3611
Taapurau, S	1924	130	5	84	38	3	....	2.3000
Pafatu, S	1907	1	....	....	1	....	....	3.0000
Pafatu, S	1919	9	4	3	1	1	....	1.8889
Summary:								
All D	.....	2,170	23	1,050	870	177	50	2.6221
All S	.....	2,750	33	1,205	1,099	316	97	2.7233
Whole Series	.....	4,920	56	2,255	1,969	493	147	2.6789

TABLE 83—*Partula suturalis vexillum. Maramu to Faatoai Valleys. Statistics of tooth-development*

Series	Year	No.	Index					Average
			1	2	3	4	5	
Maramu, D.	1919	93	3	55	28	6	1	2.4301
Maramu, D.	1923	28	2	19	5	1	1	2.2857
Maramu, D.	1924	67	2	40	19	5	1	2.4478
Mouaroa, D.	1924	86	2	41	28	11	4	2.6977
Faataofe, D.	1923	167	16	87	43	14	7	2.4551
Faataofe, D.	1924	217	11	120	63	17	6	2.4792
Fanautaata, D.	1923	174	....	52	81	30	11	3.0000
Roroie, D.	1923	320	....	104	149	46	21	2.9500
Morioahu east, D.	1923	79	....	40	30	6	3	2.6456
Morioahu east, S.	1923	112	....	59	42	9	2	2.5893
Morioahu, D.	1923	106	....	61	35	6	4	2.5566
Morioahu, S.	1923	355	3	205	115	22	10	2.5240
Opunohu west, D.	1907	4	....	3	1	....	....	2.2500
Opunohu west, S.	1907	145	1	22	99	17	6	3.0345
Opunohu west, S.	1909	94	....	19	57	15	3	3.0213
Opunohu west, below pass, D.	1919	7	....	2	5	....	....	2.7143
Opunohu west, below pass, S.	1919	77	1	40	29	7	....	2.5455
Opunohu west, below pass, D.	1923	3	....	1	2	....	....	2.6666
Opunohu west, below pass, S.	1923	188	1	117	57	11	2	2.4468
Opunohu west, below Atiati, D.	1923	1	....	....	1	....	....	3.0000
Opunohu west, below Atiati, S.	1923	371	1	199	131	30	10	2.7306
Opunohu west, Vaiarahi, S.	1924	161	1	90	56	12	2	2.5275
Tupuna, S.	1923	173	1	83	61	17	11	2.7341
Vaiana, D.	1923	1	....	....	1	....	....	3.0000
Vaiana, S.	1923	76	1	42	30	3	....	2.4605
Aareo, S.	1909	1	....	....	1	....	....	3.0000
Aareo, S.	1919	1	....	....	....	1	....	4.0000
Aareo, S.	1923	9	....	3	5	1	....	2.7778
Urufara, S.	1907	10	....	6	3	1	....	2.5000
Urufara, S.	1909	20	1	4	11	4	....	2.9000
Urufara south, (A), S.	1923	12	....	11	1	....	....	2.0833
Urufara south, (B), S.	1923	1	....	....	1	....	....	3.0000
Urufara south, (C), S.	1923	48	....	33	14	1	....	2.2666
Urufara north central, S.	1924	60	1	35	22	1	1	2.4333
Faatoai, S.	1909	16	....	2	10	1	3	3.3125
Faatoai, S.	1919	59	2	19	24	9	5	2.9322
Faatoai, Mave, S.	1923 1924	24	....	14	8	1	1	2.5417
Faatoai, upper Mave, S.	1923	14	....	8	6	....	....	2.4286
Faatoai, Taatuapæ, S.	1923	17	....	1	8	1	....	2.5882
Faatoai, Vaipapa, S.	1924	15	....	10	4	1	....	2.4000
Faatoai, Terahimaue, S.	1923	6	1	3	1	1	....	2.3333
Faatoai, Mataitau, S.	1923	5	....	4	1	....	....	2.2000
Summary:								
Maramu—Roroie, D.		1,152	36	518	416	130	52	2.6910
Morioahu east—Vaiana, D.		201	....	107	75	12	7	2.1970
Morioahu east—Vaiana, S.		1,752	10	876	677	143	46	2.6227
Aareo—Faatoai, S.		319	5	160	120	24	10	2.6050
Whole series		3,424	51	1,661	1,288	309	115	2.6425

TABLE 84—*Partula suturalis vexillum. Tefeo to Paparoa Valleys. Statistics of tooth-development (all dextral)*

Series	Year	No.	Index					Average
			1	2	3	4	5	
Tefeo	1923	42	10	29	2	1	....	1.8572
Tefeo east	1923	53	36	16	....	1	....	1.3585
Fareaito	1923	177	169	8	....	....	....	1.0452
Fareaito	1924	36	36	....	....	....	....	1.0000
Irua	1919	6	6	....	....	....	....	1.0000
Irua	1923	49	46	3	....	....	....	1.0612
Ririofau	1924	59	58	1	....	....	....	1.0169
Poua	1919	62	62	....	....	....	....	1.0000
Poua	1923	53	46	7	....	....	....	1.1321
Mouaputa (A)	1919	136	134	2	....	....	....	1.0147
Mouaputa (B)	1919	218	212	6	....	....	....	1.0275
Mouaputa	1923	190	182	8	....	....	....	1.0421
Paparoa	1909	2	....	1	1	....	....	2.5000
Whole series	.....	1,083	997	81	3	2	....	1.0859

TABLE 85—*Partula suturalis vexillum. Vaiare, Tepu, and Maharepa Valleys. Statistics of tooth-development*

Series	Year	No.	Index					Average
			1	2	3	4	5	
Vaiare:								
Puutu, D	1907	62	17	27	16	2	....	2.0517
Puutu, S	1907	18	5	7	5	1	....	2.1111
Puutu, D	1919	104	36	59	8	1	....	1.7308
Puutu, S	1919	47	16	29	2	....	....	1.7021
Vaipohe, D	1919	5	3	2	....	....	....	1.4000
Vaipohe, S	1919	1	1	....	....	....	....	1.0000
Vaipohe, D	1924	164	78	82	4	....	....	1.5488
Vaipohe, S	1924	3	2	1	....	....	....	1.3333
Faamaariri, D	1919	154	49	94	10	1	....	1.7483
Faamaariri, S	1919	86	37	45	4	....	....	1.6163
Faamaariri (A), D	1923	79	10	53	12	3	1	2.1392
Faamaariri (A), S	1923	69	9	46	12	2	....	2.1014
Faamaariri (B), D	1923	132	18	95	17	2	....	2.0227
Faamaariri (B), S	1923	143	21	115	7	....	....	1.9021
Faamaariri, D	1924	172	36	130	5	1	....	1.8314
Faamaariri, S	1924	28	7	19	2	....	....	1.8215
Tepu, S	1919	22	3	11	8	....	....	2.2273
Maharepa, S	1923	79	8	56	15	....	....	2.0886
Summary:								
All D	.....	872	247	542	72	10	1	1.8257
All S	.....	496	109	329	55	3	....	1.9033
Whole series	.....	1,368	356	871	127	13	1	1.8538

TABLE 86—*Partula suturalis vexillum. Vaianai Valley. Statistical description of the color classes (all dextral)*

Series	No.	Mean value						
		Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Vaianai, 1907, **strigata**	2	17.7500±0.5723	9.7000±0.2862	54.5000±0.0	9.5000±0.1908	6.8000±0.2384	71.5000±0.4769	53.5000±0.4769
frenata	202	18.7242± .0382	10.3544± .0206	55.2525± .0981	9.5455± .0237	7.1673± .0171	75.0544± .1120	50.8268± .0827
bisecta	8	18.7250± .1419	10.1250± .0806	54.0000± .3954	9.4000± .1192	7.0250± .0672	74.5000± .3527	50.1250± .4602
atra[1]	1	19.85	10.50	52.50	10.30	7.10	78.50	51.50
Vaianai, 1907, all	213	18.7204± .0374	10.3404± .0203	55.1855± .0953	9.5431± .0232	7.1582± .0167	75.0258± .1089	50.8287± .0816
Vaianai, 1923, **strigata**	5	18.6900± .0886	10.6200± .0295	56.5000± .4266	9.5800± .1354	7.0600± .0591	73.5000± .5723	51.1000± .7289
frenata	74	18.9527± .0706	10.6216± .0333	56.3514± .1775	9.6756± .0310	7.3162± .0302	75.3244± .1815	51.2703± .1613
bisecta	14	18.9429± .1776	10.6714± .0665	56.7143± .5623	9.5428± .0627	7.3714± .0464	77.0000± .5222	50.7243± .3426
atra[1]	1	18.15	10.10	55.50	8.70	6.70	76.50	47.50
Vaianai, 1923, all	94	18.9287± .0621	10.6234± .0283	56.4043± .1649	9.6404± .0282	7.3042± .0222	75.4894± .1738	51.1383± .1275

[1] Class values.

TABLE 87—*Partula suturalis vexillum. Uufau Valley. Statistical description of the color classes*

Series	No.	Mean value						
		Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Uufau, 1907, D, strigata	5	19.8500±0.2358	10.7800±0.1052	54.1000±0.4433	10.1000±0.1079	7.6600±0.1106	75.7000±0.7176	51.1000±0.4091
frenata	22	19.3282± .1537	10.3546± .0673	53.6363± .3439	9.9454± .0720	7.4455± .0602	74.9091± .4328	51.3182± .2400
Uufau, 1907, D, all	27	19.3833± .1361	10.4333± .0620	53.7592± .2947	9.9741± .0624	7.4852± .0542	75.0555± .3794	51.2778± .2100
Uufau, 1907, S, strigata	23	18.8978± .0961	10.6913± .0601	56.4130± .1851	9.8478± .0685	7.6043± .0475	77.2522± .2608	51.9782± .2189
frenata	166	19.1199± .0454	10.6916± .0246	55.8253± .1148	9.8880± .0244	7.5819± .0198	76.4759± .1285	51.7108± .0921
zonata	2	19.8500± .0	10.8000± .0477	54.0000± .2384	10.1000± .0954	7.5000± .0954	74.5000± .0	50.5000± .4769
bisecta[1]	1	18.05	10.70	59.50	9.70	7.50	76.50	53.50
Uufau, 1907, S, all	192	19.0953± .0414	10.6927± .0219	55.8958± .1034	9.8844± .0227	7.5833± .0161	76.5364± .1163	51.7396± .0845
Uufau, 1923, D, strigata	20	18.5900± .1354	10.5200± .0814	56.5000± .3694	9.5100± .0766	7.3100± .0677	76.6000± .3012	51.2500± .2973
frenata	105	18.7738± .0501	10.5781± .0274	56.1571± .1439	9.6066± .0267	7.3476± .0202	76.5190± .1667	50.8905± .1271
basalis[1]	1	20.45	11.30	55.50	10.10	7.70	76.50	49.50
cestata	2	17.9000± .2092	10.0000± .0477	56.5000± .9539	9.2000± .0477	7.1000± .0954	77.5000± .9539	51.0000± .7154
bisecta[1]	1	19.55	10.70	54.50	9.90	7.10	77.50	51.50
atra	2	18.6500± .1431	10.3000± .0	55.5000± .4769	9.3000± .1908	7.1000± .0954	76.0000± .2384	50.0000± .7154
Uufau, 1923, D, all	131	18.7492± .0469	10.5626± .0260	56.1870± .1300	9.5870± .0251	7.3397± .0197	76.5458± .1425	50.9275± .1133
Uufau, 1923, S, strigata	65	18.4284± .0643	10.4815± .0306	56.8692± .1812	9.5584± .0310	7.4600± .0264	77.9307± .1803	51.8231± .1519
frenata	247	18.5334± .0357	10.4020± .0156	56.0668± .0926	9.6190± .0184	7.4657± .0137	77.6336± .1098	51.8360± .0774
basalis[1]	1	17.75	10.10	56.50	9.10	7.30	80.50	51.50
zonata	2	18.6500± .2861	10.3000± .0	55.5000± .9539	9.4000± .0477	7.4000± .0477	78.0000± .2384	50.5000± .9539
bisecta	2	18.9500± .2861	10.4000± .1431	54.5000± .0	10.1000± .1908	7.7000± .0954	77.0000± .7154	53.0000± .2384
atra	3	18.1500± .3352	9.6333± .1323	53.1666± .3671	9.3000± .1908	7.0333± .0971	75.8333± .4857	51.5000± .0
Uufau, 1923, S, all	320	18.5094± .0309	10.4094± .0140	56.1906± .0825	9.6037± .1019	7.4613± .0120	77.6844± .0931	51.8281± .0677

[1] Class values.

TABLE 88—*Partula suturalis vexillum. Maraarii Valley. Statistical description of the color classes (all sinistral)*

Series	No.	Mean value						
		Shell			Aperture			Length aperture÷length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Maraarii, 1907, strigata	54	18.8833±0.0663	10.5037±0.0376	55.5555±0.1881	9.4889±0.0388	7.2666±0.0317	76.5926±0.1829	50.0556±0.1816
frenata	146	18.7445± .0389	10.5109± .0203	55.8726± .1147	9.5383± .0203	7.2877± .0177	76.2877± .1352	50.7397± .1025
zonata	21	18.6214± .1000	10.4048± .0613	55.7381± .3426	9.4714± .0631	7.2810± .0566	76.7857± .2768	50.5952± .3241
bisecta	5	18.5300± .2187	10.3800± .0903	55.7000± .6983	9.5000± .1375	7.2600± .0965	76.3000± .0401	51.0000± .4091
atra	70	18.6243± .0631	10.4600± .0315	56.1857± .1563	9.5028± .0320	7.3286± .0228	76.8571± .1922	51.0714± .1551
Maraarii, 1907, all	296	18.7290± .0285	10.4879± .0150	55.9257± .0805	9.5155± .0153	7.2926± .0126	76.5135± .0903	50.6892± .0754
Maraarii, 1923, strigata	21	18.6500± .0893	10.2238± .0619	54.8809± .2507	9.6143± .0459	7.2524± .0480	75.2143± .3749	51.6428± .2238
frenata	221	18.8794± .0377	10.2792± .0106	54.3507± .0942	9.7136± .0208	7.3597± .0158	75.7036± .1134	51.3778± .0762
cestata	4	18.3500± .1012	9.9000± .1261	53.7500± .4988	9.5000± .0954	7.2000± .1012	75.5000± .4130	51.7500± .2796
zonata	16	18.6125± .0944	10.2750± .0531	55.2500± .2828	9.7375± .0417	7.4000± .0413	76.0000± .3265	52.3750± .3203
bisecta	23	18.6500± .1293	10.2044± .0688	54.5435± .2734	9.6913± .0459	7.3174± .0574	75.5000± .3131	51.8043± .2172
atra	79	19.0070± .0680	10.3126± .0396	54.0823± .1797	9.7607± .0370	7.4164± .0323	75.8671± .2021	51.2342± .1422
Maraarii, 1923, all	364	18.8618± .0296	10.2742± .0156	54.3681± .0747	9.7154± .0160	7.3632± .0130	75.7143± .0882	51.4668± .0611

TABLE 89—*Partula suturalis vexillum. Faataofe Valley. Statistical description of the color classes (all dextral)*

Series	No.	Mean value						
		Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Faataofe, 1923, strigata	5	19.8500±0.0572	10.7800±0.0295	54.3000±0.2257	9.9400±0.0703	7.6200±0.0295	76.9000±0.5594	49.9000±0.3076
frenata	70	20.4071± .0609	11.0600± .0288	54.0000± .1485	10.2172± .0369	7.7457± .0267	75.7285± .1793	50.0229± .1472
zonata	4	20.1500± .1239	11.1500± .1295	55.5000± .4769	10.1000± .0954	7.8000± .1212	77.7500± .6022	50.0000± .2920
bisecta	46	20.2282± .0970	11.0261± .0475	54.4348± .1905	10.1609± .0502	7.7261± .0331	76.1304± .2761	50.1739± .1878
atra	29	20.2224± .0897	11.0783± .0552	54.9138± .2762	10.2586± .0548	7.8793± .0438	76.6724± .3156	50.9138± .2988
Faataofe, 1923, all	154	20.2941± .0441	11.0408± .0224	54.3507± .1037	10.1961± .0252	7.7623± .0182	76.1169± .1349	50.2403± .1061
Faataofe, 1924, apex[1]	1	21.05	11.60	56.50	11.10	8.30	75.50	52.50
strigata	10	20.6300± .2864	11.1000± .1041	53.9000± .5242	10.1800± .1132	7.6400± .0715	75.0000± .4599	49.3000± .4938
frenata	69	20.4413± .0595	11.2507± .0374	54.8478± .1736	10.3493± .0322	7.8275± .0313	75.5000± .2132	50.4420± .1526
zonata	3	20.1500± .0953	11.5000± .0636	56.8333± .1836	10.1000± .0636	7.8333± .0971	77.8333± .4857	49.5000± .3179
bisecta	64	20.2718± .0603	11.1188± .0361	54.7500± .1671	10.2313± .0381	7.7312± .0329	75.5156± .2401	50.3750± .1471
atra	44	20.4023± .0817	11.2364± .0523	54.9091± .2026	10.2591± .0541	7.7773± .0407	75.6818± .2407	50.1364± .1878
Faataofe, 1924, all	191	20.3840± .0385	11.2026± .0229	54.8194± .1016	10.2801± .0225	7.7764± .0191	75.5576± .1279	50.2854± .0910

[1] Class values.

TABLE 90—*Partula suturalis vexillum. Roroie Valley. Statistical description of the color classes (all dextral)*

Series	No.	Mean value						
		Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Roroie, 1923, strigata	21	20.2214±0.1218	11.1857±0.0606	54.9286±0.3293	10.0143±0.0700	7.6238± .0626	76.0238±0.4078	49.3572±0.3726
frenata	133	19.6876± .0433	10.9451± .0260	55.5000± .1066	9.7767± .0256	7.4624± .0182	76.3421± .1497	49.6504± .1025
cestata[1]	1	19.55	10.70	54.50	9.30	7.30	78.50	46.50
zonata	6	20.1500± .2133	10.8666± .0922	53.5000± .2753	9.9333± .0587	7.4000± .0527	74.8333± .2052	49.0000± .4964
bisecta	61	19.7664± .0677	10.9295± .0351	55.2049± .1307	9.8508± .0371	7.4967± .0269	76.2213± .1764	49.6967± .1468
atra	81	19.7389± .0663	10.9321± .0365	55.4012± .1366	9.8655± .0331	7.5000± .0278	75.9555± .1690	49.9691± .1274
Roroie, 1923, all	303	19.7628± .0313	10.9528± .0174	55.3317± .0701	9.8333± .0172	7.4888± .0131	76.1666± .0925	49.7013± .0903

[1] Class values.

TABLE 91—*Partula suturalis vexillum. Morioahu Valley. Statistical description of the color classes*

Series	No.	Mean value						
		Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Murioahu, 1923, D, strigata[1]	1	20.45	10.70	52.50	9.90	7.50	75.50	48.50
frenata	94	19.5691±0.0626	10.9127±0.0333	55.6702±0.1412	9.9042±0.0300	7.6553±0.0243	77.2873±0.1632	50.5851±0.1298
zonata	3	19.4500± .1457	10.9000± .1101	55.8333± .8002	9.7666± .0367	7.6333± .0971	78.1666±1.0221	49.8333± .4857
bisecta[1]	1	20.45	11.30	55.50	10.50	7.90	74.50	51.50
Morioahu, 1923, D, all	99	19.5833± .0603	10.9141± .0319	55.6414± .1379	9.9061± .0297	7.6637± .0234	77.2677± .1600	50.5505± .1254
Morioahu, 1923, S, strigata	2	19.7000± .2146	10.8200± .1144	56.3000± .1908	9.9800± .1869	7.9800± .1663	79.3000± .5562	51.3000± .7631
frenata	292	19.2182± .0351	10.7760± .0158	56.0274± .0864	9.7979± .0181	7.6850± .0144	78.4041± .0967	50.9212± .0733
zonata	10	19.2800± .1125	10.8200± .0719	56.2000± .3171	9.9200± .0773	7.9400± .0597	79.5000± .6745	51.3000± .2664
bisecta[1]	1	19.55	11.30	57.50	10.30	8.10	78.50	52.50
Murioahu, 1923, S, all	305	19.2244± .0339	10.7806± .0154	56.0377± .0835	9.8075± .0177	7.6994± .0143	78.4541± .0956	50.9492± .0713

[1] Class values.

TABLE 92—*Partula suturalis strigosa. Statistical description*

Series	Year	No.	Shell			Aperture			Length aperture ÷ length shell, proportions
			Length	Width	Proportions	Length	Width	Proportions	
Range (class values)									
			mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Paia	1919	13	17.15 −18.65	9.9 −10.7	54.5 −58.5	9.3 −10.3	7.1 −7.7	72.5 −77.5	50.5 −55.5
Maatea	1907	209	15.35 −19.25	8.9 −10.9	51.5 −61.5	7.9 −10.1	6.1 −7.9	70 5 −82 5	46.5 −56.5
Maatea	1924	321	15.65 −20.45	9.1 −11.3	52.5 −64.5	7.9 −10.3	6.1 −7.9	69.5 −84 5	46 5 −56 5
Haumi	1907	307	15.35 −19.85	8.7 −11.3	49.5 −62.5	8.1 −10.3	6.1 −8.1	68.5 −84.5	47.5 −57.5
Haumi	1919	267	16.25 −20.45	9.1 −11.3	49.5 −60.5	8.3 −10.7	6.1 −8.1	69.5 −81 5	46.5 −57.5
Haumi	1924	1,111	15.35 −19.85	8.5 −11.3	50.5 −62.5	7.9 −10.3	5.9 −7.9	67.5 −83.5	46.5 −56 5
Hotutea	1907	214	15.05 −20.15	8.5 −11.1	47.5 −61.5	8.3 −10.7	6.1 −7.9	67.5 −80.5	46 5 −56 5
Hotutea	1924	547	15.05 −20.75	8.5 −11.5	49.5 −63.5	7.5 −10.5	5.7 −7.9	67.5 −82.5	46.5 −57.5
Atiraa	1907	112	15.65 −19.55	9.1 −11.1	51.5 −62.5	8.3 −10.3	6.3 −7.9	68.5 −80.5	47.5 −55.5
Atiraa	1924	189	15.05 −19.55	8.9 −11.3	50.5 −63.5	8.1 −10.3	6.1 −7.9	70.5 −82.5	47.5 −57.5
All	....	3,290	15.05 −20.75	8.5 −11.5	47.5 −64.5	7.5 −10.7	5.7 −8.1	67.5 −84.5	46.5 −57.5
Mean value									
Paia	1919	13	18.0731 ± 0.0777	10.2846 ± 0.0518	56.8077 ± 0.2364	9.6539 ± 0.0532	7.2846 ± 0.0343	75.1146 ± 0.2598	53.2693 ± 0.2220
Maatea	1907	209	17.7600 ± .0325	9.8971 ± .0164	55.5957 ± .0862	9.1057 ± .0189	6.9698 ± .0149	76.4330 ± .1022	51.4617 ± .0771
Maatea	1924	321	17.7052 ± .0296	10.1704 ± .0144	57.4128 ± .0747	9.1411 ± .0160	7.0059 ± .0124	76.5031 ± .0863	51.5467 ± .0662
Haumi	1907	307	17.6435 ± .0309	9.9749 ± .0149	56.4544 ± .0836	9.1677 ± .0168	6.9567 ± .0127	75.7182 ± .0939	51.9462 ± .0678
Haumi	1919	267	18.0084 ± .0321	10.1165 ± .0150	56.1254 ± .0873	9.3562 ± .0163	7.0581 ± 0131	75.3914 ± .0950	51.8296 ± .0751
Haumi	1924	1,111	17.5605 ± .0158	9.9289 ± .0100	56.4676 ± .0427	9.0763 ± .0084	6.8125 ± .0067	74.9212 ± .0474	51.5999 ± .0364
Hotutea	1907	214	17.9014 ± .0365	10.0617 ± .0182	56.1215 ± .1006	9.3187 ± .0208	6.9738 ± .0157	74.8691 ± .1063	51.9299 ± .0909
Hotutea	1924	547	17.6436 ± .0307	9.9468 ± .0138	56.2678 ± .0689	9.0835 ± .0158	6.8386 ± .0116	75.1362 ± .0674	51.4196 ± .0570
Atiraa	1907	112	17.9696 ± .0523	10.0054 ± .0259	55.7143 ± .1395	9.3357 ± .0263	7.0304 ± .0223	75.3750 ± .1448	51.8661 ± .1168
Atiraa	1924	189	17.5754 ± .0420	10.0418 ± .0213	57.0291 ± .0944	9.2239 ± .0207	6.9603 ± .0172	75.3678 ± .1056	52.4312 ± .0918
All	....	3,290	17.6842 ± .0100	9.9921 ± .0049	56.4909 ± .0256	9.1539 ± .0053	6.9073 ± .0042	75.3584 ± .0280	51.6699 ± .0218
Standard deviation									
Paia	1919	13	0.4154 ± 0.0549	0.2769 ± 0.0366	1.2639 ± 0.1671	0.2845 ± 0.0376	0.1833 ± 0.0242	1.3887 ± 0.1837	1.1867 ± 0.1570
Maatea	1907	209	.6977 ± .0230	.3519 ± .0116	1.8484 ± .0609	.4066 ± .0133	.3189 ± .0105	2.1907 ± .0722	1.6539 ± .0545
Maatea	1924	321	.7881 ± .0209	.3841 ± .0102	1.9840 ± .0528	.4263 ± .0113	.3311 ± .0087	2.2925 ± .0610	1.7600 ± .0468
Haumi	1907	307	.8020 ± .0218	.3884 ± .0105	2.1713 ± .0591	.4366 ± .0119	.3309 ± .0090	2.4398 ± .0664	1.7627 ± .0479
Haumi	1919	267	.7772 ± .0227	.3627 ± .0106	2.1152 ± .0617	.3956 ± .0115	.3183 ± .0092	2.3027 ± .0672	1.8185 ± .0531
Haumi	1924	1,111	.7836 ± .0112	.4047 ± .0071	2.1133 ± .0302	.4155 ± .0059	.3314 ± .0047	2.3434 ± .0335	1.7996 ± .0257
Hotutea	1907	214	.7930 ± .0258	.3946 ± .0128	2.1836 ± .0711	.4514 ± .0147	.3415 ± .0111	2.3059 ± .0751	1.9723 ± .0643
Hotutea	1924	547	1.0668 ± .0217	.4809 ± .0097	2.3904 ± .0302	.5476 ± .0112	.4031 ± .0082	2.3374 ± .0476	1.9763 ± .0403
Atiraa	1907	112	.8204 ± .0370	.4070 ± .0183	2.1894 ± .0986	.4125 ± .0186	.3502 ± .0157	2.2722 ± .1024	1.8322 ± .0826
Atiraa	1924	189	.8569 ± .0297	.4337 ± .0150	1.9246 ± .0667	.4233 ± .0146	.3515 ± .0121	2.1525 ± .0747	1.8717 ± .0649
All	....	3,290	.8518 ± .0071	.4185 ± .0034	2.1815 ± .0181	.4545 ± .0037	.3558 ± .0029	2.3803 ± .0198	1.8531 ± .0154

TABLE 93—*Partula suturalis strigosa. Statistics of tooth-development*

Series	Year	No.	Index					Average
			1	2	3	4	5	
Paia	1919	14	4	10	...	...	...	1.6923
Maatea	1907	238	77	134	27	...	...	1.7899
Maatea	1924	341	88	252	1	...	...	1.7449
Haumi	1907	421	147	242	31	1	...	1.7292
Haumi	1919	328	106	216	6	...	...	1.6951
Haumi	1924	1,230	351	876	3	...	...	1.7171
Hotutea	1907	283	83	151	49	...	..	1.8798
Hotutea	1924	641	105	521	15	...	...	1.8596
Atiraa	1907	128	17	74	37	...	...	2.1562
Atiraa	1924	211	48	157	5	...	1	1.8104
All	....	3,835	1,026	2,633	174	1	1	1.7791

TABLE 94—*Partula suturalis strigosa. Statistical description of the color classes*

Mean value

Series	No.	Shell			Aperture			Length aperture ÷length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Paia, 1907, strigata	7	18.2214±0.0803	10.2143±0.0600	55.9286±0.2306	9.5857±0.0600	7.2714±0.0504	75.5000±0.3854	52.6429±0.2523
cingulata	5	17.8700± .1470	10.3800± .0980	57.9000± .2413	9.7400± .1038	7.3000± .0539	74.7000± .3518	54.1000± .3076
phæa [1]	1	18.05	10.30	57.50	9.70	7.30	74.50	53 50
Maatea, 1907, strigata	32	17.7313± .0929	9.8813± .0439	55.6250± .1757	9.0875± .0490	6.9312± .0358	76.2500± .2043	51.1625± .1339
frenata	33	17.9227± .0720	9.6666± .0399	55.4091± .2051	9.2636± .0430	7.0878± .0409	76.2273± .2606	51.4697± .1816
cingulata	79	17.7196± .0534	9.9456± .0300	56.0063± .1498	9.1076± .0316	7.0380± .0235	76.8924± .1553	51.1583± .1295
zonata	26	17.6577± .0879	9.8539± .0338	55.7307± .2386	9.0000± .0416	6.8846± .0327	76.5384± .3369	50.9231± .1947
bisecta	37	17.8149± .0766	9.7919± .0285	54.8514± .1880	9.0568± .0458	6.8946± .0340	75.7703± .2624	50 9054± .1849
phæa	2	17.4500± .0	9.6000± .1431	54.0000± .7154	9.0000± .0477	6.8000± .0477	75.5000± .4769	51 0000± .2384
Maatea, 1924, strigata	29	17.5535± .0955	10.1138± .0509	57.7069± .2450	9.0242± .0520	6.9759± .0420	76.9483± .2495	51.3276± .1987
frenata	120	17.6750± .0496	10.1716± .0238	57.4666± .1294	9.1500± .0251	6.9934± .0193	76.2666± .1374	51.6833± .1051
cingulata	112	17.8223± .0503	10.2196± .0233	57.3125± .1241	9.1928± .0268	7.0468± .0215	76.5357± .1565	51.5535± .1173
zonata	29	17.5845± .0743	10.1690± .0398	57.8793± .1996	9.1345± .0522	7.0172± .0420	76.9138± .2854	51.5310± .2295
bisecta	29	17.6155± .1127	10.0379± .0558	56.9483± .2251	9.0104± .0552	6.9276± .0431	76.5345± .2600	51.0173± .1947
phæa	2	18.2000± .0715	10.1000± .0	55.5000± .4769	9.1000± .0954	6.9000± .0	76.0000± .7154	50 0000± .7154
Haumi, 1907, strigata	83	17.6162± .0601	9.9602± .0310	56.4880± .1487	9.1361± .0308	6.9554± .0248	75.8735± .1820	51.8855± .1319
frenata	34	17.7676± .0963	9.9470± .0385	56.0000± .2481	9.1941± .0539	6.9353± .0370	75.2353± .2606	51.7941± .1695
cingulata	155	17.6474± .0417	10.0135± .0203	56.6226± .1225	9.2019± .0232	6.9826± .0175	75.7903± .1359	52.0419± .0936
bisecta	25	17.5220± .0973	9.8440± .0520	56.1000± .2531	9.0840± .0615	6.8520± .0453	75.2600± .3129	52.0600± .2908
phæa	10	17.6900± .2441	9.9200± .0883	56.0000± .5159	9.0200± .1065	6.9000± .0714	76.1000± .3192	51.2000± .3706
Haumi, 1919, pallida [1]	1	18.35	10.30	56.50	9.50	7.30	77.50	51.50
strigata	62	18.1468± .0649	10.1903± .0276	56.0967± .1660	9.4032± .0356	7.1032± .0264	75.4355± .1970	51.7258± .1495
frenata	29	17.9466± .1007	10.1345± .0395	56.4310± .2789	9.4103± .0516	7.0931± .0439	75.3966± .3003	52.1896± .2571
cingulata	89	17.9759± .0563	10.0573± .0283	55.9045± .1645	9.3314± .0282	7.0146± .0233	75.1180± .1689	51.8483± .1385
bisecta	56	17.9643± .0669	10.1178± .0316	56.2500± .3618	9.3071± .0318	7.0500± .0273	75.6785± .1897	51.5893± .1554
phæa	30	17.9500± .0983	10.1133± .0467	56.3000± .2323	9.3666± .0485	7.0666± .0366	75.5000± .2844	52.1000± .1759
Haumi, 1924, pallida	2	17.6000± .0715	10.4000± .2384	59.0000± .7154	9.1000± .0944	6.7000± .0	76.0000± .7154	51.5000± .4769
strigata	303	17.5005± .0299	9.9686± .0153	56.8531± .0828	9.0353± .0160	6.5858± .0126	74.8531± .0864	51.5990± .0693
frenata	173	17.4396± .0403	9.8468± .0206	56.3671± .1009	8.9937± .0208	6.7613± .0154	75.0491± .1145	51.4885± .0845
cingulata	447	17.5671± .0258	9.9183± .0128	56.2316± .0673	9.0911± .0134	6.8289± .0111	74.9854± .0804	51.5246± .0594
zonata	4	17.9750± .2982	10.2000± .0584	57.0000± .6952	9.4000± .1012	7.0500± .0997	75.2500± .4988	52.2500± .3675
bisecta	127	17.6933± .0437	9.9549± .0236	56.2559± .1249	9.1724± .0224	6.8796± .0183	74.8228± .1261	51.7598± .1057
phæa	55	17.4309± .0664	9.9582± .0414	56.9363± .1914	9.1218± .0405	6.8091± .0311	74.5363± .2087	52.1545± .1629
Hotutea, 1907, strigata	9	17.3500± .1526	9.7445± .0552	56.2777± .4831	8.8112± .0640	6.7222± .0447	76.6111± .5240	50.5000± .4239
frenata	120	17.9275± .0485	10.0517± .0193	55.9583± .1374	9.3250± .0282	6.9516± .0199	74.5250± .1416	51.8916± .1222
cingulata	25	18.2420± .0919	10.1960± .0436	55.7000± .2698	9.4280± .0517	7.0760± .0447	75.1000± .2531	51.6600± .2403
bisecta	53	17.7670± .0755	10.0547± .0364	56.5943± .2006	9.3151± .0389	6.9943± .0333	75.1604± .2159	52.2924± .1812
phæa	7	17.9643± .1671	10.2143± .1214	56.6428± .3175	9.5000± .1307	7.1571± .1122	75.5000± .5098	52 6428± .3714
Hotutea, 1924, strigata	22	16.6046± .1375	9.4909± .0652	57.1363± .3374	8.7455± .0406	6.5000± .0433	74.3182± .3512	52.3636± .2306
frenata	348	17.9914± .0335	10.0592± .0157	55.7586± .0813	9.2172± .0187	6.9213± .0138	75.0230± .0843	51.1035± .0706
cingulata	86	16.4942± .0563	9.5861± .0319	58.0116± .1560	8.6186± .0336	6.5512± .0270	76.0232± .1511	52.0930± .1355
bisecta	86	17.6175± .0650	9.9419± .0324	56.3372± .1696	9.1325± .0337	6.8558± .0264	74.8604± .1689	51.7209± .1430
phæa	5	18.2300± .2660	10 4200± .1458	56 7000± .4433	9.5000± .1706	7.2200± .0818	76.1000± .7772	52.5000± .5047
Atiraa, 1907, strigata	14	17.7072± .1425	9.9572± .0585	56.2857± .4874	9.2429± .0517	6.9429± .0390	75.2857± .3743	52 2143± .3298
frenata	13	18.1423± .1653	10.1154± .0796	55.9615± .3993	9.4384± .0885	7.1154± .0680	75.7307± .4764	52.0384± .3166
cingulata	80	18.0163± .0611	10.0025± .0311	55.5500± .1612	9.3550± .0313	7.0350± .0270	75.2125± .1587	51.8000± .1423
bisecta	3	17.9700± .3920	10.0333± .1468	57.5000± .7788	8.9666± .0734	7.0333± .0734	78.8333± .6616	51.8333± .3671
phæa	2	17.9000± .3577	9.7000± .1908	54 0000± .2384	9.1000± .1908	6.9000± .2862	75.0000±1.6693	51.0000± .2384
Atiraa, 1924, strigata	17	17.3618± .1416	10.1470± .0610	58.0882± .3369	9.2177± .0539	6.9941± .0490	76.0294± .4527	52.9117± .2752
frenata	15	17.5100± .1652	10.1400± .0864	56.2333± .3787	9.3533± .0724	7.0333± .0578	75.1000± .3466	51.8333± .2891
cingulata	146	17.5424± .0468	10.0165± .0244	56.9795± .1214	9.1987± .0241	6.9438± .0202	75.3494± .1191	52.3904± .1630
bisecta	9	17.7166± .1666	10.1444± .0509	57.5000± .3965	9.4555± .0786	7.0555± .0591	74.8333± .2997	53.3888± .2691
phæa	2	17.6000± .2623	9.8000± .2384	55.5000 .4769	9.1000± .1908	6.9000± .0954	75 5000± .0	51.5000± .4769

TABLE 95—*Partula suturalis. Statistics of fecundity*

Series	Year	Records	No. of gravid	Per cent gravid	Eggs	Young	Total contents	Average for gravid	Average for all
P. suturalis vexillum:									
Atimaha	1907	97	81	83.50	155	60	215	2.65	2.21
Atimaha	1919	5	4	80.00	4	2	6	1.50	1.20
Atimaha	1923	164	126	76.83	214	167	381	3.02	1.84
Paahonu	1919	37	30	81.08	35	48	83	2.76	2.24
Vaianai	1907	235	191	81.27	345	132	477	2.50	1.06
Vaianai	1919	29	22	75.86	28	25	53	2.41	1.83
Vaianai	1923	98	76	77.55	125	107	232	3.05	1.37
Oio	1923	158	125	79.11	222	168	390	3.12	2.47
Haapiti	1907	240	167	69.58	231	188	419	2.51	1.74
Haapiti	1923	255	195	76.47	331	255	586	3.00	2.30
Uufau	1907	299	243	81.27	453	236	689	2.83	2.31
Uufau	1923	503	434	86.28	761	512	1,273	2.93	2.53
Moruu	1909	115	87	75.65	149	102	251	2.88	2.18
Moruu	1923	395	325	82.28	519	413	932	2.87	2.36
Varari	1909	197	173	87.82	344	206	550	3.18	2.79
Varari	1923	322	282	87.58	467	426	893	3.17	2.77
Maraarii	1907	382	338	88.48	747	336	1,083	3.20	2.83
Maraarii	1923	398	314	78.89	519	347	866	2.76	2.18
Maatepua	1924	6	4	66.66	8	3	11	3.75	1.83
Taapurau	1923	36	19	52.77	37	14	51	2.68	1.42
Taapurau	1924	125	81	64.80	111	100	211	2.60	1.69
Pafatu	1907	1	1	100.	3	1	4	4.00	4.00
Pafatu	1919	8	8	100.	13	6	19	2.37	2.37
P. suturalis vexillum:									
Maramu	1919	91	79	86.81	90	109	199	2.52	2.19
Maramu	1923	28	19	67.78	18	26	44	2.31	1.57
Maramu	1924	65	51	78.46	88	62	150	2.94	2.31
Mouaroa	1924	83	60	72.29	85	67	152	2.53	1.83
Faataofe	1923	164	147	89.63	150	288	438	2.98	2.67
Faataofe	1924	211	193	91.47	348	247	595	3.08	2.82
Fanautaata	1923	171	157	91.81	250	307	557	3.55	3.26
Roroie	1923	312	288	92.31	474	559	1,033	3.59	3.31
Morioahu east	1923	188	173	92.02	252	347	599	3.46	3.19
Morioahu	1923	453	414	91.39	517	687	1,204	2.91	2.66
Opunohu west	1907	125	94	75.20	134	129	263	2.80	2.10
Opunohu west	1909	93	71	76.34	109	79	188	2.65	2.02
Opunohu west, below pass	1919	84	69	82.14	97	85	182	2.64	1.16
Opunohu west, below pass	1923	189	160	84.65	305	239	544	3.40	2.88
Opunohu west, below Atiati	1923	367	326	88.83	614	470	1,084	3.33	2.95
Opunohu west, Vairahi	1924	158	125	79.11	201	134	335	2.68	2.12
Tupuna	1923	170	144	84.70	181	206	387	2.69	2.28
Vaiana	1923	76	57	75.00	60	76	136	2.38	1.79
Aareo	1909	1	1	100.	3	.....	3	3.00	3.00
Aareo	1919	2	2	100.	3	2	5	2.50	2.50
Aareo	1923	9	5	55.55	6	3	9	1.80	1.00
Urufara	1907	10	4	40.00	5	8	13	3.25	1.30
Urufara	1909	19	13	68.42	18	18	36	2.77	1.89
Urufara south (A)	1923	12	8	66.66	13	7	20	2.50	1.66
Urufara south (B)	1923	1	1	100.	2	1	3	3.00	3.00
Urufara south (C)	1923	47	27	57.44	35	27	62	2.29	1.32
Urufara north center	1924	59	38	64.41	71	62	133	3.50	2.25
Faatoai	1909	15	14	93.33	26	25	51	3.74	3.40
Faatoai	1919	50	26	52.00	34	27	61	2.34	1.22
Faatoai, Mave	1923 1924	23	19	82.60	31	21	52	2.74	2.26
Faatoai, Mave upper	1923	14	10	71.43	18	10	28	2.80	2.00
Faatoai, Taatuapæ	1923	15	9	60.00	13	15	28	3.11	1.86
Faatoai, Vaipapa	1924	15	6	40.00	8	8	16	2.66	1.06
Faatoai, Terahimaue	1923	4	2	50.00	3	.....	3	1.50	0.75
Faatoai, Mataitau	1923	5	1	20.00	1	.....	1	1.00	0.20

TABLE 95—*Partula suturalis. Statistics of fecundity*—Continued

Series	Year	Records	No. of gravid	Per cent gravid	Eggs	Young	Total contents	Average for gravid	Average for all
P. suturalis vexillum:									
Tefeo	1923	40	26	65.00	31	45	76	2.92	1.90
Tefeo east	1923	53	49	92.45	68	89	157	3.20	2.96
Fareaito	1923	177	161	90.94	203	298	501	3.11	2.83
Fareaito	1924	36	34	94.44	55	41	96	2.82	2.67
Irua	1919	6	6	100.	8	11	19	3.16	3.16
Irua	1923	49	43	87.77	59	83	142	3.30	2.90
Ririofau	1924	59	52	88.13	86	89	175	3.36	2.96
Poua	1919	62	57	91.93	80	72	152	2.67	2.45
Poua	1923	53	45	84.91	84	82	166	3.69	3.13
Mouaputa (A)	1919	133	124	93.23	154	206	360	2.90	2.71
Mouaputa (B)	1919	217	203	93.55	230	331	561	2.76	2.58
Mouaputa	1923	179	169	94.41	275	293	568	3.36	3.17
Paparoa	1909	1	1	50.00	1	3	4	4.00	2.00
Vaiare-Puutu	1907	80	62	77.50	93	87	180	2.90	2.25
Vaiare-Puutu	1919	151	101	66.86	161	83	244	2.41	1.61
Vaiare-Vaipohe	1919	6	5	83.33	7	7	14	2.80	2.33
Vaiare-Vaipohe	1924	165	122	73.94	188	153	341	2.79	1.69
Vaiare-Faamaariri	1919	235	156	66.38	238	152	390	2.50	1.66
Vaiare-Faamaariri (A)	1923	132	114	86.36	208	174	382	3.35	2.89
Vaiare-Faamaariri (B)	1923	272	204	75.00	335	294	629	3.08	2.31
Vaiare-Faamaariri	1924	197	156	79.19	208	185	393	2.52	1.99
Tepu	1919	20	13	65.00	27	11	38	2.92	1.90
Maharepa	1923	78	57	73.08	92	75	167	2.93	2.14
P. suturalis strigosa:									
Paia	1919	13	6	46.15	9	.....	9	1.50	0.69
Maatea	1907	228	155	67.98	249	61	310	2.00	1.36
Maatea	1924	322	178	55.28	219	177	396	2.22	1.23
Haumi	1907	410	213	51.95	275	117	392	1.84	0.95
Haumi	1919	321	249	77.57	385	399	784	3.15	2.44
Haumi	1924	1,168	685	58.65	809	533	1,342	1.96	1.15
Hotutea	1907	239	205	85.77	346	147	493	2.79	2.06
Hotutea	1924	601	397	66.05	430	371	801	2.02	1.33
Atiraa	1907	127	91	71.65	122	55	177	1.94	1.39
Atiraa	1924	201	81	40.29	72	85	157	1.94	0.78
Summary:									
vexillum:									
Atimaha—Pafatu	.....	4,105	3,326	81.02	5,821	3,854	9,675	2.91	2.40
Maramu—Vaiana	.....	3,028	2,627	86.75	3,973	4,117	8,090	3.06	2.67
Aareo—Faatoai	.....	301	186	61.79	290	234	524	2.82	1.74
Tefeo—Paparoa	.....	1,066	970	90.99	1,334	1,643	2,977	3.07	2.79
Vaiare—Maharepa	.....	1,336	990	73.08	1,557	1,221	2,778	2.80	2.08
vexillum: all	.....	9,836	8,099	82.34	12,975	11,069	24,044	2.97	2.44
strigosa: all	.....	3,630	2,260	62.26	2,916	1,945	4,861	2.15	1.34
Whole species	.....	13,466	10,359	76.93	15,891	13,014	28,905	2.79	2.15

TABLE 96—*Partula suturalis. Recorded adults and their embryonic contents*

Number of eggs	Number of young					Totals	
	0	1	2	3	4		
0	3,107	378	231	43	3	3,762	
1	1,253	1,293	1,494	354	11	4,405	
2	970	1,547	1,567	353	14	4,451	15,891
3	268	295	207	36	2	808	eggs
4	19	17	4	...	..	40	
Totals	5,617	3,530	3,503	786	30	13,466 records	
		13,014 young					

Summary	Embryonic contents							
	0	1	2	3	4	5	6	7
Number of adults: 13,466	3,107	1,631	2,494	3,352	2,238	588	54	2

TABLE 97—*Partula suturalis vexillum. Relations of dextral and sinistral components in mixed colonies*

Series	Adult population		Gravid adults with young		Embryonic population		Parent-offspring relations	
	Number	Per cent	Number	Per cent	Number	Per cent	Dextral young	Sinistral young
Haapiti, 1907, D	223	92.53	110	90.16	116	94.32	109	2
S	18	7.47	12	9.84	7	5.68	7	5
Uufau, 1907, D	38	12.54	19	11.37	30	12.71	7	19
S	265	87.46	148	88.73	206	87.29	23	187
Uufau, 1923, D	156	29.27	104	31.42	163	31.83	101	56
S	377	70.73	188	68.58	349	68.17	62	293
Morioahu east, 1923, D	79	41.36	62	38.99	135	38.90	97	38
S	112	58.64	97	61.00	212	61.10	45	167
Morioahu, 1923, D	106	22.99	85	22.37	103	14.99	58	88
S	355	77.00	295	77.63	584	85.01	45	496
Vaiare-Puutu, 1907, D	62	77.50	40	81.63	36	73.47	30	10
S	18	22.50	9	18.37	13	26.53	6	3
Vaiare-Puutu, 1919, D	104	68.87	38	66.66	58	69.88	40	15
S	47	31.13	19	33.33	25	30.12	18	10
Vaiare-Vaipohe, 1919, D	5	83.33	3	75.00	5	71.43	5	...
S	1	16.66	1	25.00	2	28.57	...	2
Vaiare-Vaipohe, 1924, D	164	98.20	103	99.04	153	100.	152	...
S	3	1.80	1	0.96	0	0	1	...
Vaiare-Faamaariri, 1919, D	154	64.16	75	68.89	98	64.47	86	21
S	86	35.83	34	31.11	54	35.53	12	33
Vaiare-Faamaariri, 1923 (A), D	79	53.38	57	59.37	85	48.85	72	34
S	69	46.61	39	40.73	89	51.15	13	55
Vaiare-Faamaariri, 1923 (B), D	132	48.00	84	50.00	158	53.74	123	28
S	143	52.00	84	50.00	136	46.26	35	108
Vaiare-Faamaariri, 1924, D	172	86.00	101	87.74	165	89.19	155	5
S	28	14.00	14	12.25	20	10.81	10	15

TABLE 98—*Partula suturalis. Summary statistical description*

Series	No.	Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
Mean value								
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
vexillum, dextral	4,707	19.7778±0.0113	10.8724±0.0054	54.9508±0.0218	10.0213±0.0060	7.5307±0.0046	75.4127±0.0263	50.6041±0.0196
vexillum, sinistral	4,570	19.0382± .0107	10.5499± .0066	55.3707± .0230	9.7454± .0056	7.4691± .0043	76.6114± .0260	51.1221± .0190
vexillum, all	9,277	19.4134± .0082	10.7135± .0039	55.1577± .0159	9.8853± .0042	7.5111± .0031	76.0032± .0189	50.8593± .0137
strigosa, all	3,290	17.6842± .0100	9.9921± .0049	56.4909± .0256	9.1539± .0053	6.9073± .0042	75.3584± .0280	51.6699± .0218
suturalis, all	12,567	18.9607± .0080	10.5247± .0037	55.5067± .0140	9.6939± .0039	7.3531± .0039	75.8344± .0159	51.0715± .0118
vexillum as compared with *strigosa*	.....	+1.7292± .0129	+0.7214± .0063	−1.3332± .0301	+0.7314± .0067	+0.6038± .0052	+0.6438± .0338	−0.5106± .0257
Standard deviation								
vexillum, dextral	4,707	1.1543±0.0080	0.5497±0.0038	2.2219±0.0154	0.6117±0.0042	0.4732±0.0032	2.6742±0.0186	2.0003± .0138
vexillum, sinistral	4,570	1.0719± .0075	.6620± .0046	2.3087± .0162	.5629± .0039	.4341± .0030	2.6062± .0184	1.9112± .0134
vexillum, all	9,277	1.1742± .0058	.5587± .0027	2.2748± .0112	.6041± .0029	.4505± .0022	2.7080± .0133	1.9617± .0097
strigosa, all	3,290	0.8518± .0071	.4185± .0034	2.1815± .0181	.4545± .0037	.3561± .0029	2.3803± .0198	1.8531± .0154
suturalis, all	12,567	1.3363± .0056	.6139± .0026	2.3243± .0099	.6534± .0027	.6512± .0027	2.6414± .0112	1.9664± .0083

TABLE 99—*Partula tæniata elongata. Outer series. Statistical description*

Range (class values)

Series	Year	No.	Shell						Aperture						Length aperture ÷length shell, proportions	
			Length		Width		Proportions		Length		Width		Proportions			
			mm.		*mm.*		*p. ct.*		*mm.*		*mm.*		*p. ct.*		*p. ct.*	
Haapiti	1907	28	15.35	−19.25	9.1	−10.5	53.5	−60.5	8.3	−10.1	6.1	−7.1	67.5	−76.5	49.5	−57.5
Haapiti	1923	144	13.25	−17.45	7.7	− 9.9	49.5	−63.5	7.1	− 9.5	4.9	−6.7	62.5	−79.5	48.5	−61.5
Oio, D	1919	474	12.65	−19.25	7.7	−10.7	48.5	−64.5	7.3	− 9.9	5.1	−7.3	60.5	−78.5	45.5	−59.5
Oio	1923	47	13.85	−17.15	7.7	− 9.7	50.5	−60.5	7.5	− 9.3	4.9	−6.9	63.5	−76.5	47.5	−57.5
Vaianai	1907	93	14.75	−18.95	7.7	−10.3	49.5	−60.5	7.7	−10.1	5.1	−7.1	63.5	−72.5	49.5	−59.5
Vaianai	1919	328	14.45	−18.65	8.1	−10.1	49.5	−62.5	7.9	−10.3	5.3	−7.1	63.5	−75.5	49.5	−60.5
Vaianai	1923	50	14.15	−17.15	7.7	− 9.5	49.5	−61.5	8.1	− 9.5	5.1	−6.7	63.5	−72.5	51.5	−60.5
Paahonu	1919	52	14.45	−19.35	8.1	− 0.9	49.5	−59.5	7.9	−10.3	5.7	−6.9	62.5	−74.5	48.5	−57.5
Atimaha	1907	5	15.95	−17.75	8.7	− 9.1	51.5	−55.5	8.7	− 9.5	5.9	−6.3	61.5	−70.5	52.5	−57.5
Atimaha	1919	373	14.15	−18.65	7.9	−10.1	49.5	−61.5	7.9	−10.1	5.1	−7.1	60.5	−76.5	50.5	−61.5
Atimaha	1923	145	13.55	−17.45	8.1	− 9.9	51.5	−61.5	7.7	− 9.9	5.3	−6.9	63.5	−74.5	49.5	−60.5
Maatea	1907	12	15.05	−17.75	8.5	−10.1	53.5	−61.5	8.3	−10.3	5.9	−7.3	65.5	−74.5	54.5	−59.5
Maatea	1924	88	14.15	−18.65	7.7	−10.5	50.5	−61.5	8.1	−10.5	5.1	−7.3	62.5	−73.5	49.5	−60.5
Haumi	1907	3	15.35	−16.25	8.5	− 9.3	54.5	−60.5	8.3	− 9.3	5.5	−6.5	64.5	−70.5	50.5	−60.5
Haumi	1919	48	14.45	−18.65	7.9	−10.1	50.5	−59.5	7.9	−10.1	5.3	−6.9	63.5	−71.5	48.5	−58.5
Haumi	1924	103	13.55	−18.35	7.5	− 9.9	50.5	−61.5	7.7	− 9.9	4.9	−6.7	61.5	−73.5	50.5	−59.5
All	....	1,993	12.65	−19.35	7.5	−10.7	48.5	−64.5	7.1	−10.5	4.9	−7.3	60.5	−79.5	45.5	−61.5

Mean value

Haapiti	1907	28	17.1393	± 0.1093	9.6286	± 0.0415	55.9286	± 0.2443	9.1714	± 0.0480	6.5428	±0.0369	71.7143	± 0.2733	53.2143	± 0.2947
Haapiti	1923	144	15.4750	± .0471	8.6778	± .0270	55.9931	± .1241	8.3333	± .0242	5.7347	± .0221	68.7500	± .1567	53.7701	± .1087
Oio, D	1919	474	16.0569	± .0271	9.0621	± .0149	56.3270	± .0730	8.6443	± .0129	6.0591	± .0114	69.8291	± .0847	53.9468	± .0597
Oio	1923	47	15.7840	± .0873	8.7298	± .0441	55.2660	± .2437	8.4234	± .0419	5.7468	± .0372	67.8191	± .2849	53.4149	± .2017
Vaianai	1907	93	16.6693	± .0572	9.2204	± .0327	55.2205	± .1655	9.1387	± .0318	6.2742	± .0273	68.4140	± .1620	54.5860	± .1412
Vaianai	1919	328	16.3716	± .0313	9.2220	± .0150	56.1982	± .0798	9.0653	± .0165	6.2738	± .0122	69.0244	± .0852	55.2775	± .0728
Vaianai	1923	50	15.6620	± .0603	8.9000	± .0377	56.7800	± .2133	8.8560	± .0358	6.0160	± .0333	67.6400	± .2216	56.4800	± .1784
Paahonu	1919	52	16.9423	± .0697	9.1615	± .0380	54.0770	± .2054	9.1692	± .0365	6.3346	± .0259	68.6154	± .2424	54.0385	± .1506
Atimaha	1907	5	16.6700	± .1056	8.8600	± .0451	53.3000	± .4826	9.3000	± .1706	6.0600	± .0591	66.1000	± .8866	55.5000	± .5723
Atimaha	1919	373	16.0224	± .0297	8.9112	± .0145	55.5911	± .0727	8.8062	± .0166	6.0341	± .0127	68.3258	± .0807	54.8723	± .0622
Atimaha	1923	145	15.9479	± .0403	8.8780	± .0229	55.6724	± .1153	8.8642	± .0231	6.0269	± .0180	67.7138	± .1181	55.5758	± .1112
Maatea	1907	12	16.1750	± .1671	9.1666	± .0861	56.5833	± .4666	9.1833	± .0986	6.5833	± .0683	69.5833	± .4799	56.7500	± .2987
Maatea	1924	88	16.4193	± .0680	9.1614	± .0359	55.6818	± .1620	9.2114	± .0370	6.2818	± .0308	68.1023	± .1705	55.7841	± .1396
Haumi	1907	3	15.6928	± .1081	8.9286	± .0573	56.6428	± .4400	8.7000	± .1081	5.9000	± .1081	67.6428	± .4400	55.3572	± .6642
Haumi	1919	48	16.2375	± .0808	8.9875	± .0428	55.3542	± .1810	8.8875	± .0433	6.0542	± .0300	67.7500	± .1596	54.6458	± .1740
Haumi	1924	103	15.7986	± .0560	8.7699	± .0341	53.4321	± .1583	8.6766	± .0300	5.8864	± .0260	67.7039	± .1550	54.7718	± .1165
All	....	1,993	16.1127	± .0137	9.0125	± .0073	55.9135	± .0345	8.8190	± .0076	6.0824	± .0060	68.7599	± .0391	54.6340	± .0313

TABLE 99—*Partula tæniata elongata. Outer series. Statistical description*—Continued

Series	Year	No.	Shell			Aperture			Length aperture ÷ length shell, proportions
			Length	Width	Proportions	Length	Width	Proportions	
Standard deviation									
			mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Haapiti	1907	28	0.8579± 0.0773	0.3261± 0.0293	1.9167± 0.1727	0.3769± 0.0339	0.2896±0.0261	2.1440± 0.1932	2.3123± 0.2084
Haapiti	1923	144	.8388± .0333	.4808± .0191	2.2079± .0877	.4301± .0171	.3932± .0156	2.7874± .1108	1.9338± .0768
Oio, D	1919	474	.8760± .0191	.4804± .0105	2.3572± .0516	.4166± .0091	.3673± .0080	2.7346± .0599	1.9271± .0422
Oio	1923	47	.8878± .0617	.4481± .0312	2.4772± .1723	.4259± .0296	.3786± .0263	2.8961± .2014	2.0507± .1426
Vaianai	1907	93	.8185± .0404	.4685± .0231	2.3663± .1170	.4555± .0225	.3904± .0193	2.3171± .1145	2.0195± .0998
Vaianai	1919	328	.8419± .0221	.4043± .0106	2.1421± .0564	.4433± .0116	.3275± .0086	2.2883± .0602	1.9543± .0515
Vaianai	1923	50	.6320± .0426	.3959± .0266	2.2364± .1508	.3758± .0253	.3489± .0235	2.3239± .1567	1.8707± .1261
Paahunu	1919	52	.7455± .0493	.4067± .0269	2.1957± .1452	.3900± .0258	.2766± .0183	2.5918± .1714	1.6107± .1065
Atimaha	1907	5	.3501± .0747	.1496± .0319	1.6000± .3412	.5656± .1206	.1959± .0418	2.9394± .6269	1.8973± .4047
Atimaha	1919	373	.8516± .0210	.4168± .0102	2.0820± .0514	.4758± .0117	.3630± .0090	2.3108± .0570	1.7812± .0440
Atimaha	1923	145	.7192± .0285	.4089± .0162	2.0589± .0815	.4133± .0163	.3210± .0127	2.0589± .0815	2.1080± .0835
Maatea	1907	12	.8584± .1181	.4422± .0609	2.3965± .3299	.5063± .0697	.3508± .0483	2.4650± .3393	1.5343± .2112
Maatea	1924	88	.9467± .0481	.4994± .0254	2.2534± .1145	.5151± .0261	.4292± .0218	2.3719± .1205	1.9420± .0987
Haumi	1907	3	.4242± .0764	.2250± .0405	1.7261± .3111	.4242± .0764	.4242± .0764	1.6413± .2958	2.6056± .4696
Haumi	1919	48	.8305± .0571	.4395± .0302	1.8595± .1280	.4452± .0306	.3089± .0212	1.6393± .1128	1.7882± .1230
Haumi	1924	103	.8432± .0396	.5129± .0241	2.3822± .1119	.4522± .0212	.3914± .0184	2.3332± .1096	1.7526± .0824
All	....	1,993	.9066± .0097	.4818± .0051	2.2865± .0244	.5019± .0054	.3985± .0042	2.5912± .0276	2.0733± .0221
Appendix (class values)									
Oio, S	1919	1	17.45	10.50	59.5	9.90	7.30	73.5	56.5

TABLE 100—*Partula tæniata elongata. Inner series. Statistical description*

Series	Year	No.	Shell			Aperture			Length aperture ÷length shell, proportions
			Length	Width	Proportions	Length	Width	Proportions	
			mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Range (class values)									
Maramu	1909	30	15.35 −18.05	8.3 − 9.7	52.5 −57.5	8.3 −10.1	5.9 −7.1	65.5 −76.5	51.5 −59.5
Maramu	1919	89	14.15 −17.75	7.7 − 9.5	49.5 −58.5	7.9 −10.1	5.3 −7.3	65.5 −74.5	51.5 −59.5
Maramu	1923	29	14.45 −17.45	7.9 − 9.3	47.5 −56.5	8.3 − 9.9	5.5 −6.9	65.5 −75.5	50.5 −58.5
Maramu	1924	299	14.45 −18.65	7.5 − 9.7	46.5 −59.5	7.7 −10.1	5.3 −7.3	63.5 −76.5	49.5 −59.5
Tefeo	1923	123	13.55 −18.05	7.7 − 9.7	48.5 −59.5	7.9 − 9.9	5.5 −7.3	65.5 −75.5	49.5 −60.5
Tefeo east	1923	171	14.15 −18.65	7.7 − 9.7	48.5 −58.5	8.1 −10.7	5.3 −7.3	63.5 −78.5	52.5 −60.5
Fareaito	1923	586	13.55 −18.95	7.3 −10.7	47.5 −60.5	7.5 −10.3	5.1 −7.3	63.5 −78.5	49.5 −61.5
Fareaito	1924	527	13.85 −17.75	7.5 − 9.9	48.5 −60.5	7.7 −10.3	5.1 −7.3	62.5 −78.5	49.5 −61.5
Irua	1907	65	14.15 −19.55	8.3 −10.3	50.5 −61.5	7.7 −10.3	5.5 −7.5	68.5 −76.5	51.5 −58.5
Irua (A)	1919	32	15.05 −18.65	8.1 −10.1	49.5 −58.5	8.3 −10.3	5.9 −7.5	65.5 −77.5	51.5 −58.5
Irua (B)	1919	154	14.75 −18.95	8.1 −10.1	48.5 −58.5	8.5 −10.3	5.7 −7.3	64.5 −75.5	49.5 −59.5
Irua	1923	133	14.45 −17.75	7.5 − 9.7	46.5 −58.5	8.1 −10.1	5.3 −7.1	64.5 −74.5	51.5 −60.5
Ririofau	1924	289	15.05 −18.95	8.1 −10.3	48.5 −61.5	8.3 −10.5	5.7 −7.5	65.5 −78.5	50.5 −61.5
Poua	1919	20	16.25 −19.55	8.7 −10.7	51.5 −60.5	9.1 −10.7	6.5 −7.9	66.5 −75.5	50.5 −59.5
Poua	1923	43	15.05 −18.65	8.3 −10.3	48.5 −56.5	8.5 −10.5	5.9 −7.3	64.5 −74.5	51.5 −58.5
Mouaputa (A)	1919	112	13.55 −18.35	7.5 −10.9	50.5 −60.5	7.7 −10.3	5.3 −7.5	59.5 −76.5	51.5 −63.5
Mouaputa (B)	1919	279	13.55 −18.35	7.7 −10.1	48.5 −61.5	7.7 −10.3	5.1 −7.5	62.5 −77.5	51.5 −61.5
Mouaputa	1923	75	14.75 −19.85	8.3 −10.5	50.5 −59.5	8.3 −10.9	5.7 −7.7	64.5 −75.5	52.5 −60.5
All	.....	3,056	13.55 −19.85	7.3 −10.9	46.5 −61.5	7.5 −10.9	5.1 −7.9	59.5 −78.5	49.5 −63.5
Mean value									
Maramu	1909	30	16.6000± 0.0843	9.0200± 0.0530	54.4000± 0.1994	9.2666± 0.0562	6.5333±0.0407	70.3733± 0.3217	55.9000± 0.2555
Maramu	1919	89	16.3343± .0600	8.7831± .0293	53.6685± .1344	9.1180± .0351	6.3786± .0270	70.0169± .1508	55.7359± .1313
Maramu	1923	29	16.2914± .0818	8.6035± .0392	52.6378± .2542	8.9552± .0496	6.2862± .0347	70.0173± .2944	54.8103± .2441
Maramu	1924	299	16.0855± .0299	8.5187± .0157	52.8913± .0778	8.8137± .0178	6.1836± .0138	69.9648± .0868	54.7374± .0685
Tefeo	1923	123	15.9646± .0460	8.5829± .0223	53.6382± .1275	8.8382± .0267	6.2317± .0203	70.3699± .1367	55.2073± .1254
Tefeo east	19	171	16.1465± .0422	8.6930± .0189	53.8976± .0934	9.0158± .0235	6.2988± .0174	69.7339± .1241	55.7339± .0883
Fareaito	1923	586	16.0380± .0213	8.5560± .0108	53.2372± .0558	8.8577± .0123	6.2635± .0096	70.5358± .0656	55.1092± .0541
Fareaito	1924	527	15.8606± .0200	8.5603± .0105	53.8681± .0580	8.8207± .0117	6.1444± .0098	69.5152± .0706	55.4953± .0524
Irua	1907	65	16.4023± .0806	9.1738± .0353	55.8846± .1866	8.9246± .0405	6.4877± .0306	72.5615± .1723	54.3154± .1467
Irua (A)	1919	32	16.6062± .1009	9.1312± .0556	54.9687± .2210	9.2688± .0631	6.4563± .0265	71.0000± .3040	55.7500± .1757
Irua (B)	1919	154	16.7175± .0414	9.0013± .0224	53.7727± .1175	9.2610± .0223	6.4792± .0179	70.2857± .1257	55.2987± .1005
Irua	1923	133	16.2275± .0421	8.7301± .0222	53.7406± .1130	9.1646± .0245	6.3887± .0183	69.5827± .1248	56.3948± .1209
Ririofau	1924	289	16.7558± .0320	9.1014± .0156	54.2128± .0852	9.2834± .0176	6.6433± .0135	71.4758± .0907	55.3236± .0668
Poua	1919	20	17.9750± .1356	9.7100± .0671	54.1500± .3546	10.0200± .0735	7.1100± .0518	70.2000± .3604	55.8000± .2944
Poua	1923	43	17.3872± .0897	9.3279± .0475	53.4768± .1965	9.5931± .0522	6.7139± .0369	69.9651± .2166	54.9884± .1620
Mouaputa (A)	1919	112	16.1670± .0689	8.9946± .0357	55.6160± .1388	9.0554± .0343	6.3518± .0297	69.8571± .1776	55.8035± .1302
Mouaputa (B)	1919	279	16.0683± .0366	8.6934± .0195	54.0627± .0853	9.0398± .0177	6.3337± .0164	69.8979± .1135	56.1058± .0778
Mouaputa	1923	75	16.8580± .0715	9.3080± .0330	55.1666± .1572	9.4574± .0400	6.6707± .0274	70.4600± .1825	55.9800± .1368
All	.....	3,056	16.2150± .0106	8.7400± .0058	53.8184± .0261	9.0038± .0060	6.3360± .0048	70.2582± .0302	55.4163± .0233

TABLE 100—*Partula tæniata elongata. Inner series. Statistical description*—Continued

Series	Year	No.	Standard deviation							
			Shell			Aperture			Length aperture ÷ length shell, proportions	
			Length	Width	Proportions	Length	Width	Proportions		
			mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*	
Maramu	1909	30	0.6845 ± 0.0596	0.4308 ± 0.0375	1.6197 ± 0.1410	0.4563 ± 0.0397	0.3310 ± 0.0288	2.6616 ± 0.2275	2.0752 ± 0.1806	
Maramu	1919	89	.8401 ± .0424	.4098 ± .0207	1.8799 ± .0950	.4914 ± .0248	.3776 ± .0191	2.1100 ± .1066	1.8361 ± .0928	
Maramu	1923	29	.6531 ± .0578	.3135 ± .0277	2.0295 ± .1797	.3962 ± .0351	.2776 ± .0245	2.3507 ± .2082	1.9494 ± .1726	
Maramu	1924	299	.7673 ± .0211	.4019 ± .0111	1.9943 ± .0550	.4576 ± .0126	.3551 ± .0097	2.2251 ± .0615	1.7562 ± .0484	
Tefeo	1923	123	.7572 ± .0325	.3677 ± .0157	2.0963 ± .0901	.4396 ± .0189	.3343 ± .0143	2.2486 ± .0966	2.0629 ± .0887	
Tefeo east	1923	171	.8191 ± .0298	.3670 ± .0133	1.8112 ± .0660	.4567 ± .0166	.3368 ± .0123	2.4069 ± .0877	1.7116 ± .0624	
Fareaito	1923	586	.7667 ± .0151	.3896 ± .0076	2.0040 ± .0394	.4430 ± .0087	.3452 ± .0069	2.3544 ± .0464	1.9418 ± .0382	
Fareaito	1924	527	.6806 ± .0141	.3585 ± .0074	1.9755 ± .0410	.4001 ± .0083	.3330 ± .0069	2.4041 ± .0499	1.7846 ± .0370	
Irua	1907	65	.9634 ± .0570	.4218 ± .0249	2.2305 ± .1319	.4842 ± .0286	.3660 ± .0216	2.0597 ± .1218	1.7532 ± .1037	
Irua (A)	1919	32	.8466 ± .0713	.4667 ± .0393	1.8538 ± .1563	.5294 ± .0446	.2221 ± .0187	2.5495 ± .2149	1.4736 ± .1242	
Irua (B)	1919	154	.7622 ± .0293	.4117 ± .0158	2.1631 ± .0831	.4103 ± .0157	.3296 ± .0126	2.3130 ± .0889	1.8495 ± .0710	
Irua	1923	133	.7196 ± .0297	.3795 ± .0157	1.9317 ± .0799	.4188 ± .0173	.3135 ± .0129	2.1347 ± .0882	2.0675 ± .0855	
Ririofau	1924	289	.8068 ± .0226	.3943 ± .0110	2.1478 ± .0602	.4439 ± .0124	.3411 ± .0095	2.2864 ± .0641	1.6844 ± .0472	
Poua	1919	20	.8994 ± .0959	.4449 ± .0474	2.3511 ± .2507	.4874 ± .0520	.3434 ± .0366	2.3895 ± .2548	1.9519 ± .2082	
Poua	1923	43	.8718 ± .0634	.4617 ± .0336	1.9107 ± .1389	.5073 ± .0369	.3593 ± .0261	2.1059 ± .1531	1.5756 ± .1145	
Mouaputa (A)	1919	112	1.0811 ± .0487	.5612 ± .0252	2.1784 ± .0981	.5383 ± .0242	.4658 ± .0210	2.7866 ± .1256	2.0434 ± .0920	
Mouaputa (B)	1919	279	.9081 ± .0259	.4841 ± .0138	2.1138 ± .0603	.4378 ± .0125	.4066 ± .0116	2.8104 ± .0802	1.9276 ± .0550	
Mouaputa	1923	75	.9165 ± .0505	.4239 ± .0233	2.0154 ± .1111	.5126 ± .0283	.3513 ± .0194	2.3406 ± .1290	1.7539 ± .0967	
All	.....	3,056	.8737 ± .0075	.4762 ± .0041	2.1365 ± .0184	.4934 ± .0042	.3954 ± .0034	2.4738 ± .0213	1.9076 ± .0165	

TABLE 101—*Partula tæniata elongata. Rotui region. Statistical description*

Series	Year	No.	Shell			Aperture			Length aperture + length shell, proportions
			Length	Width	Proportions	Length	Width	Proportions	
Range (class values)									
			mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Matapoopoo	1909	89	13.55 −18.35	7.7 −9.9	51.5 −61.5	7.3 −9.7	5.1 −6.9	64.5 −76.5	48.5 −59.5
Matapoopoo west	1923	79	13.85 −17.45	7.5 −9.7	49.5 −60.5	7.7 −9.5	5.3 −6.9	62.5 −76.5	50.5 −60.5
Tepatu	1923	6	15.65 −17.45	8.5 −9.3	53.5 −56.5	8.7 −9.3	5.9 −6.7	65.5 −70.5	53.5 −58.5
All	.....	174	13.55 −18.35	7.5 −9.9	51.5 −61.5	7.3 −9.7	5.1 −6.9	62.5 −76.5	48.5 −60.5
Mean value									
Matapoopoo	1909	89	15.6197 ± 0.0665	8.8573 ± 0.0343	56.7247 ± 0.1484	8.4933 ± 0.0371	6.0213 ± 0.0276	70.7696 ± 0.1663	54.2191 ± 0.1301
Matapoopoo west	1923	79	15.7411 ± .0523	8.7303 ± .0266	55.3861 ± .1588	8.7405 ± .0295	6.0824 ± .0256	69.4747 ± .1882	55.4241 ± .1512
Tepatu	1923	6	16.3000 ± .1611	9.0000 ± .0692	55.0000 ± .3078	9.1000 ± .0635	6.2666 ± .0740	68.3333 ± .4329	55.8333 ± .4401
All	.....	174	15.6983 ± .0425	8.8046 ± .0238	56.0575 ± .1107	8.6264 ± .0245	6.0406 ± .0186	70.1207 ± .1266	54.8218 ± .1082
Standard deviation									
Matapoopoo	1909	89	0.9304 ± 0.0470	0.4801 ± 0.0242	2.0753 ± 0.1049	0.5188 ± 0.0262	0.3858 ± 0.0195	2.3260 ± 0.1176	1.8205 ± 0.0920
Matapoopoo west	1923	79	.6989 ± .0370	.3502 ± .0188	2.0927 ± .1123	.3889 ± .0208	.3374 ± .0181	2.4802 ± .1331	1.9925 ± .1069
Tepatu	1923	6	.5852 ± .1139	.2516 ± .0489	1.1180 ± .2176	.2309 ± .0449	.2687 ± .0523	1.5723 ± .3060	1.5983 ± .3111
All	.....	174	.8324 ± .0300	.4662 ± .0168	2.1649 ± .0783	.4805 ± .0173	.3633 ± .0131	2.4763 ± .0895	2.1172 ± .0765

TABLE 102—*Partula tæniata elongata. Statistical description of the color classes of illustrative series*

Series	No.	Mean value						
		Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
Outer series:		*mm.*	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Oio, 1919, pallida	100	16.2500±0.0616	9.0980±0.0315	55.8300±0.1532	8.7180±0.0329	6.1320±0.0256	70.0500±0.1845	53.5400±0.1307
fusca	178	16.0090± .0409	9.1078± .0242	56.7528± .1301	8.6214± .0189	6.0584± .0184	70.0112± .1429	53.7416± .1016
fulva (D)	119	16.0357± .0548	8.9135± .0293	56.0546± .1301	8.5841± .0239	5.9572± .0211	69.1555± .1653	54.0210± .1202
fulva (S)[1]	1	17.45	10.50	59.50	9.90	7.30	73.50	56.50
frenata	46	16.2565± .0896	9 1782± .0440	56.5000± .2252	8.6957± .0438	6.1608± .0329	70.5652± .2303	53.3913± .2002
zonata	31	16.1532± .0978	9.0807± .0585	56.2742± .2255	8.6936± .0513	6.0968± .0466	69.5645± .2950	53.9193± .1891
Vaianai, 1907, pallida	46	16.4718± .0558	9.1348± .0466	55.2609± .2273	9.0739± .0426	6.2131± .0388	68.1739± .2318	54.9130± .1907
fusca	24	16.8250± .1420	9.2333± .0619	54.8333± .3700	9.1083± .0667	6.2333± .0566	68.0832± .3227	54.0000± .2575
fulva	14	16.9357± .1678	9.3285± .0838	55.0715± .3651	9.2285± .0836	6.3857± .0557	68.7143± .4041	54.3572± .4408
frenata	9	16.8500± .1907	9.4555± .0894	56.2777± .4469	9.4111± .0824	6.5222± .0685	70.0555± .3018	54.3889± .4028
Vaianai, 1919, pallida	135	16.4744± .0482	9.2585± .0224	56.0556± .1231	9.1103± .0252	6.3019± .0188	69.0407± .1192	55.2112± .1121
fusca	91	16.3753± .0609	9.1879± .0287	55.9945± .1509	9.0539± .0335	6.2473± .0241	68.7857± .1083	55.1704± .1245
fulva	74	16.2217± .0620	9.2135± .0344	56.6892± .1561	9.0216± .0355	6 2687± .0267	69.1216± .1897	55.5405± .1712
frenata	25	16.2020± .1119	9.1400± .0458	56.2200± .3445	8.9720± .0417	6.2440± .0280	69.2600± .2798	55.3800± .2666
zonata	3	16.7500± .3855	9.5000± .1682	56.5000± .3179	9.2333± .0971	6.6333± .0971	71.1666± .3671	55.1666± .7343
Atimaha, 1919, pallida	176	16.0267± .0402	8.9102± .0211	55.5227± .1053	8.8307± .0241	6.0364± .0192	68.1421± .1151	55.0341± .0900
fusca	113	15.9898± .0560	8.8947± .0258	55.5442± .1344	8.7549± .0274	6.0027± .0210	68.4115± .1455	54.6327± .1207
fulva	55	15.9064± .0805	8.8710± .0364	55.9363± .2021	8.7037± .0451	5.9909± .0289	68.5909± .2283	54.5545± .1476
frenata	26	16.3884± .1265	9.0923± .0603	55.5384± .2214	9.0769± .0670	6.2384± .0528	68.5384± .2946	55.4231± .1794
zonata	3	15.9500± .2524	8.7666± .1323	55.5000± .3179	8.8333± .1600	6.1000± .1682	69.1666± .4857	55.8333± .3671
Haumi, 1919, pallida	21	16.1500± .1358	8.9477± .0608	54.8810± .2105	8.8714± .0569	6.0333± .0409	67.9285± .1904	54.1666± .2920
fusca	18	16.1500± .1082	9.1222± .0726	55.8888± .2957	9.0666± .0788	6.1666± .0571	67.6666± .2914	55.3333± .2555
frenata	6	16.0000± .1299	8.9666± .0821	56.0000± .4964	8.8000± .0940	5.9000± .0318	67.1666± .4680	54.6666± .3341
zonata	3	15.6500± .0953	8.5000± .1272	54.1666±1.1166	8.4333± .0367	5.8333± .0367	68.1666± .8002	53.8333± .1836

[1] Class values.

TABLE 102—*Partula tæniata elongata. Statistical description of the color classes of illustrative series*—Continued

Inner series:								
Maramu, 1924, pallida	131	16.1035± .0454	8.5519± .0225	53.0878± .1142	8.7885± .0256	6.1748± .0198	70.0572± .1225	54.5381± .1091
fusca	119	16.0206± .0479	8.4715± .0262	52.8445± .1230	8.8025± .0300	6.1622± .0231	69.7941± .1472	54.8949± .1014
fulva	26	15.9731± .0837	8.4616± .0514	52.6923± .3003	8.7692± .0502	6.1462± .0448	70.0769± .2842	54.6923± .2140
frenata	21	16.4785± .1072	8.6238± .0525	52.0715± .2632	9.0714± .0631	6.3761± .0458	70.1190± .3322	55.0238± .2711
zonata	2	16.1000± .3577	8.8000± .1431	54.0000± .2384	9.0000± .2384	6.5000± .0954	71.0000± .7154	56 0000± .2384
Fareaito, 1923, pallida	275	16.0689± .0308	8.5713± .0157	53.2164± .0788	8.8855± .0180	6.2564± .0138	70.6563± .0967	55.1756± .0764
(lower) fusca	29	15.8983± .0837	8.4242± .0498	52.9483± .2744	8.6931± .0507	6.0862± .0426	69.9138± .3714	54.5345± .2450
fulva	52	16.0942± .0703	8.5846± .0318	53.2500± .2208	8.9192± .0326	6.3231± .0278	70.6154± .2160	55.2885± .1944
frenata	28	15.7786± .1083	8.4715± .0490	53.6428± .2543	8.6357± .0545	6.1429± .0433	71.1428± .2531	54.5357± .2113
zonata	161	16.0000± .0420	8.5261± .0215	53.1522± .1002	8.8404± .0252	6.2131± .0182	70.1646± .1158	55.1336± .0996
bisecta[1]	1	17.45	9.10	52.50	8.70	6.70	75.50	50.50
Fareaito, 1923, pallida	10	16.3100± .1481	8.6800± .0924	53.4000± .5176	9.0400± .0787	6.4400± .0764	70.8000± .3700	55.6000± .4569
(middle) fusca[1]	1	16.55	8.70	52.50	8.70	6.10	70.50	52.50
fulva	3	15.7500± .2914	8.4333± .0734	53.8333± .7343	8.7666± .1330	6.1000± .0	69.1666±1.2850	55.1666± .6618
frenata	10	15.9200± .0832	8.5400± .0372	53.1000± .2487	8.7000± .0504	6.2400± .0604	71.3000± .5463	54.0000± .2568
zonata	16	16.2125± .1237	8.8000± .0584	54.1875± .4203	9.0625± .0676	6.4750± .0557	71.3125± .3331	56.0625± .4420
Fareaito, 1924, pallida	294	15.8439± .0273	8.5272± .0147	53.6836± .0777	8.7810± .0162	6.1994± .0136	69.3300± .0949	55.2653± .0726
(upper) fusca	29	15.7845± .0875	8.5621± .0342	54.2586± .2270	8.7621± .0501	6.1690± .0318	70.2586± .3428	55.3621± .1910
fulva	21	15.9643± .1024	8.6523± .0588	54.0238± .2160	8.9381± .0503	6.2619± .0550	69.5476± .3813	55.9762± .1960
phæa-purpurea	3	16.1500± .1457	8.6333± .0734	52.8333± .3671	9.0333± .0971	6.2333± .0971	68.1666± .1836	55.8333± .6619
frenata	54	15.7833± .0529	8.5926± .0319	54.4074± .1760	8.8333± .0304	6.1778± .0283	69.8888± .2188	55.8518± .1370
zonata	126	15.9262± .0409	8.6063± .0197	53.9762± .1236	8.8968± .0240	6.2080± .0183	69.6429± .1341	55.8174± .1072
Ririofau, 1924, pallida	34	16.7088± .0895	9.1412± .0558	54.5294± .2698	9.3588± .0522	6.7235± .0472	71.7647± .2999	55.9117± .1590
fusca	27	16.8055± .1140	9.0482± .0585	53.8333± .2913	9.2556± .0575	6.5889± .0481	70.9074± .2765	55.0556± .2352
fulva	82	16.7402± .0603	9.1610± .0247	54.6097± .1628	9.2829± .0336	6.6708± .0236	71.7805± .1734	55.4025± .1267
frenata	14	17.2357± .2017	9.2428± .0616	53.4286± .3698	9.3428± .0905	6.7143± .0585	72.3571± .5399	54.1429± .2692
zonata	132	16.7159± .0434	9.0500± .0227	54.0455± .1175	9.2637± .0251	6.6091± .0191	71.2349± .1201	55.3031± .0976
Rotui sector:								
Matapoopoo, 1919, pallida	19	15.7763± .1652	8.9736± .0773	56.8158± .3255	8.6473± .0757	6.1526± .0601	71.0263± .3109	54.6579± .3105
fusca	36	15.6084± .0800	8.8112± .0495	56.2500± .1935	8.3889± .0531	5.9500± .0405	70.6666± .2616	53.6112± .2306
fulva	11	15.0500± .1964	8.7000± .0965	58.1363± .4092	8.3364± .1052	5.9000± .0736	71.1363± .5076	55.2272± .3478
zonata	12	15.9000± .1324	8.9166± .0817	56.5833± .3506	8.6500± .1180	6.1166± .0802	70.8333± .5293	54.0000± .4092
lyra	11	15.6500± .2482	8.9000± .1150	56.8636± .5434	8.5545± .0982	6.0454± .0737	70.2273± .3585	54 6818± .3860

[1] Class values.

TABLE 103—*Partula tæniata elongata. Statistics of fecundity*

Series	Year	Records	No. of gravid	Per cent gravid	Eggs	Young	Total contents	Average for gravid	Average for all
Outer series:									
Haapiti	1907	29	22	75.86	42	17	59	2.56	2.03
Haapiti	1923	158	144	91.14	229	171	400	2.78	2.53
Oio	1919	0	.....	.....	.....	.....	.....	....	....
Oio	1923	54	51	94.44	81	43	124	2.43	2.29
Vaianai	1907	85	63	74.12	91	28	119	1.89	1.40
Vaianai	1919	304	271	89.04	364	316	680	2.51	2.24
Vaianai	1923	58	53	91.38	80	62	142	2.68	2.45
Paahonu	1923	56	48	85.71	50	56	106	2.21	1.89
Atimaha	1907	6	5	83.33	7	5	12	2.40	2.00
Atimaha	1919	409	331	80.93	434	279	713	2.15	1.74
Atimaha	1923	150	135	90.00	206	149	355	2.63	2.36
Paia	1919	1	0	.....	.....	.....	.....	....	....
Maatea	1907	17	10	58.82	13	6	19	1.90	1.12
Maatea	1924	93	61	65.59	76	54	130	2.13	1.40
Haumi	1907	7	4	57.14	6	4	10	2.50	1.43
Haumi	1919	85	71	83.43	93	73	166	2.34	1.95
Haumi	1924	114	66	57.89	73	59	132	2.00	1.16
Summary	....	1,626	1,335	82.10	1,845	1,322	3,167	2.37	1.95
Inner series:									
Maramu	1909	42	38	90.47	36	43	79	2.08	1.88
Maramu	1919	124	109	87.90	130	114	244	2.24	1.97
Maramu	1923	41	35	85.36	39	36	75	2.14	1.83
Maramu	1924	252	227	90.08	337	206	543	2.39	2.15
Tefeo	1923	142	118	83.09	156	154	310	2.62	2.18
Tefeo east	1923	224	197	87.94	248	228	476	2.42	2.12
Fareaito	1923	612	552	90.19	630	849	1,479	2.68	2.42
Fareaito	1924	581	515	88.64	686	460	1,146	2.22	1.97
Irua	1907	89	67	75.28	88	58	146	2.18	1.64
Irua A	1919	34	29	85.29	46	27	73	2.52	2.15
Irua B	1919	107	100	93.46	111	116	227	2.27	2.12
Irua	1923	146	137	93.83	206	160	366	2.67	2.51
Ririofau	1924	290	273	94.14	457	363	820	3.00	2.83
Poua	1919	23	22	95.65	25	33	58	2.64	2.52
Poua	1923	44	39	88.63	69	59	128	3.28	2.91
Mouaputa A	1919	135	117	86.66	144	168	312	2.66	2.31
Mouaputa B	1919	266	237	89.09	274	282	556	2.35	2.09
Mouaputa	1923	76	70	92.10	115	100	215	3.07	2.83
Summary	....	3,228	2,882	89.28	3,797	3,456	7,253	2.52	2.25
Rotui sector:									
Matapoopoo	1909	116	90	77.59	104	73	177	1.96	1.52
Matapoopoo west	1923	105	93	88.57	111	121	232	2.49	2.21
Matapoopoo east	1923	1	1	(100)	1	0	1	1.00	1.00
Tepatu	1923	19	16	84.21	25	13	38	2.37	2.00
Summary	....	241	200	82.99	241	207	448	2.24	1.86
All	....	5,095	4,417	86.693	5,883	4,985	10,868	2.46	2.13

TABLE 104—*Partula tæniata elongata. Recorded adults and their embryonic contents*

Number of eggs	Number of young					Totals	
	0	1	2	3	4		
0	677	164	99	12	...	952	
1	561	1,023	848	66	1	2,499	5,883 eggs
2	412	707	386	46	...	1,551	
3	51	29	10	...	...	90	
4	3	.....	.....	...	...	3	
Totals	1,704	1,923	1,343	124	1	5,095 records	
		4,985 young					

Summary	Embryonic contents					
	0	1	2	3	4	5
Number of adults: 5,095	677	725	1,534	1,618	484	57

TABLE 105—*Partula tæniata elongata. Statistics of apparent heredity of coloration*

Class of parents	Number of young							
	pallida	fusca	fulva	phæa-purpurea	frenata	zonata	lyra	Total
pallida	611	1,195	299	.....	2	3	...	2,110
fusca	138	704	167	.....	...	...	...	1,009
fulva	60	423	263	.....	...	...	...	746
phæa-purpurea	...	7	7	.....	...	...	...	14
frenata	68	183	74	.....	4	5	...	334
zonata	73	281	347	.....	...	1	...	702
lyra	1	10	5	.....	...	1	1	18
bisecta	...	1	1	.....	...	...	...	2
Total	951	2,804	1,163	.....	6	10	1	4,935

TABLE 106—*Partula tæniata elongata. Comparison of embryonic and adult populations, in percentages*

Color class	Outer series		Inner series		Rotui sector		Whole series	
	Embryos	Adults	Embryos	Adults	Embryos	Adults	Embryos	Adults
pallida	17.91	35.57	19.23	45.02	28.30	25.10	19.27	40.65
fusca	67.15	35.49	52.31	14.58	60.87	37.85	56.82	23.39
fulva	13.79	18.89	28.16	13.77	9.66	11.55	23.57	15.60
phæa-purpurea	0	0	0	0.28	0	1.99	0	0.24
frenata	0.38	7.76	0.03	8.85	0	2.79	0.12	8.19
zonata	0	2.28	0.26	17.22	0.48	12.75	0.20	11.42
lyra	0	0	0	0.25	0.48	7.97	0.02	0.47
bisecta	0	0	0	0.03	0	0	0	0.16

TABLE 107—*Partula tæniata simulans. Outer western series. Statistical description*

Series	Year	No.	Range (class values)											
			Shell						Aperture				Length aperture ÷ length shell, proportions	
			Length		Width		Proportions		Length		Width		Proportions	
			mm.		*mm.*		*p. ct.*		*mm.*		*mm.*		*p. ct.*	
Pafatu	1907	286	15.05	−19.85	9.3	−11.5	51.5	−66.5	8.1	−10.5	6.1	−7.9	67.5	−82.5	47.5	−58.5
Pafatu	1919	148	14.15	−17.75	8.5	−10.5	55.5	−65.5	7.5	− 9.3	5.7	−7.3	68.5	−83.5	48.5	−58.5
Taapurau, D	1923	166	13.85	−17.75	8.7	−10.5	55.5	−64.5	7.5	− 9.5	5.5	−7.1	69.5	−80.5	48.5	−57.5
Taapurau, D	1924	753	13.25	−18.05	8.3	−11.1	53.5	−67.5	7.3	− 9.7	5.3	−7.3	68.5	−82.5	47.5	−58.5
Maatepua	1924	98	15.05	−18.95	9.1	−11.1	54.5	−65.5	8.3	−10.1	5.9	−7.7	69.5	−82.5	49.5	−58.5
Maraarii	1907	47	15.65	−18.35	8.9	−10.5	55.5	−62.5	8.3	− 9.5	6.3	−7.1	69.5	−77.5	50.5	−57.5
Maraarii	1923	434	14.45	−19.55	8.5	−11.3	53.5	−67.5	7.7	−10.3	5.7	−7.5	68.5	−83.5	49.5	−60.5
Varari	1909	57	14.45	−18.35	8.9	−10.5	56.5	−64.5	7.9	− 9.5	5.7	−6.9	68.5	−78.5	49.5	−57.5
Varari	1923	431	13.55	−18.65	8.3	−10.9	54.5	−67.5	7.5	− 9.7	5.5	−7.3	67.5	−81.5	48.5	−59.5
Moruu	1907	86	14.45	−17.75	8.7	−10.7	52.5	−67.5	8.1	− 9.7	5.7	−7.1	68.5	−80.5	48.5	−58.5
Moruu	1909	70	14.45	−17.75	8.7	−10.7	55.5	−64.5	7.7	− 9.5	5.7	−7.1	68.5	−77.5	49.5	−58.5
Moruu	1923	219	13.25	−17.75	8.1	−10.7	54.5	−66.5	7.3	− 9.5	5.3	−7.1	67.5	−81.5	49.5	−57.5
Uufau	1907	158	15.05	−18.95	8.5	−10.9	52.5	−63.5	7.7	− 9.9	5.3	−7.3	66.5	−77.5	46.5	−56.5
Uufau	1923	120	13.55	−18.35	8.1	−10.5	50.5	−63.5	7.5	− 9.5	5.3	−7.1	66.5	−77.5	47.5	−58.5
All		3,073	13.25	−19.85	8.1	−11.5	50.5	−67.5	7.3	−10.5	5.3	−7.9	66.5	−83.5	46.5	−60.5

TABLE 107—*Partula tæniata simulans. Outer western series. Statistical description*—Continued

Mean value										
Pafatu	1907	286	17.6335± 0.0357	10.4294± 0.0165	59.1469± 0.1013	9.4937± 0.0186	6.9538±0.0138	73.2308± 0.1032	53.7482± 0.0820
Pafatu	1919	148	15.5426± .0386	9.4027± .0213	60.4257± .1126	8.2649± .0204	6.3770± .0170	77.0744± .1467	52.9933± .1020
Taapurau, D	1923	166	15.9012± .0348	9.5916± .0192	60.1506± .1011	8.4771± .0185	6.4072± .0149	75.4880± .1015	53.1566± .0888
Taapurau, D	1924	753	15.7520± .0185	9.5773± .0099	60.7603± .0542	8.4514± .0100	6.3850± .0076	75.4615± .0558	53.5544± .0430
Maatepua	1924	98	16.7306± .0518	10.0327± .0283	59.9082± .1598	9.1102± .0249	6.8510± .0230	75.0000± .1496	54.4592± .1238
Maraarii	1907	47	16.7096± .0696	9.8022± .0327	58.5851± .1923	8.9170± .0329	6.5766± .0217	73.8404± .1784	53.2660± .1724
Maraarii	1923	434	16.4615± .0237	9.9364± .0141	60.2788± .0746	9.0977± .0140	6.7461± .0104	74.0345± .0689	55.1244± .0610
Varari	1909	57	16.1763± .0758	9.7210± .0315	60.0088± .1826	8.7245± .0353	6.4614± .0256	74.0439± .2118	53.7632± .1538
Varari	1923	431	15.8707± .0248	9.5710± .0122	60.2564± .0718	8.5960± .0123	6.3891± .0093	74.2355± .0720	54.0267± .0576
Moruu	1907	86	16.4872± .0457	9.7953± .0296	59.1395± .1607	8.7535± .0265	6.5093± .0225	74.1744± .1705	52.8023± .1340
Moruu	1909	70	16.1300± .0541	9.6829± .0295	59.9857± .1599	8.6943± .0287	6.4029± .0221	73.4714± .1583	53.8143± .1539
Moruu	1923	219	15.6883± .0293	9.4114± .0175	59.8607± .0901	8.4022± .0164	6.2105± .0137	73.7511± .1006	53.4224± .0784
Uufau	1907	158	16.7019± .0404	9.5658± .0233	57.2722± .1159	6.6861± .0221	6.2582± .0174	71.8861± .1189	51.9366± .0978
Uufau	1923	120	16.1851± .0530	9.2284± .0287	57.0250± .1353	8.4817± .0268	6.0934± .0206	71.7500± .1546	52.2833± .1238
All	.....	3,073	16.1869± .0116	9.7019± .0061	59.8957± .0295	8.7091± .0065	6.4831± .0047	74.3812± .0313	53.6861± .0242
Standard deviation										
Pafatu	1907	286	0.8961± 0.0251	0.4146± 0.0116	2.5415± 0.0716	0.4669± .0131	0.3453±0.0097	2.5871± 0.0730	2.0563± 0.0580
Pafatu	1919	148	.6957± .0273	.3845± .0150	2.0305± .0796	.3689± .0144	.3063± .0120	2.6460± .1037	1.8399± .0721
Taapurau, D	1923	166	.6646± .0246	.3664± .0136	1.9322± .0715	.3542± .0131	.2852± .0105	1.9388± .0718	1.6959± .0628
Taapurau, D	1924	753	.7542± .0131	.4034± .0070	2.2074± .0383	.4087± .0071	.3099± .0054	2.2693± .0394	1.7510± .0304
Maatepua	1924	98	.7602± .0366	.4159± .0200	2.3464± .1130	.3663± .0176	.3381± .0162	2.1962± .1058	1.8178± .0875
Maraarii	1907	47	.7072± .0492	.3323± .0231	1.9551± .1360	.3347± .0232	.2204± .0153	1.8134± .1261	1.7529± .1219
Maraarii	1923	434	.7323± .0167	.4362± .0100	2.3054± .0527	.4321± .0099	.3205± .0073	2.1294± .0487	1.8833± .0431
Varari	1909	57	.8490± .0536	.3528± .0223	2.0444± .1291	.3948± .0249	.2864± .0181	2.3741± .1497	1.7221± .1087
Varari	1923	431	.7638± .0175	.3747± .0086	2.2102± .0508	.3807± .0087	.2859± .0066	2.2177± .0509	1.7734± .0407
Moruu	1907	86	.6283± .0323	.4077± .0209	2.2092± .1136	.3653± .0187	.3094± .0159	2.3449± .1205	1.8428± .0947
Moruu	1909	70	.6716± .0382	.3668± .0208	1.9838± .1130	.3561± .0203	.2741± .0156	1.9637± .1119	1.9087± .1088
Moruu	1923	219	.6431± .0207	.3851± .0124	1.9776± .0637	.3598± .0116	.3004± .0097	2.2075± .0711	1.7197± .0554
Uufau	1907	158	.7583± .0285	.4348± .0165	2.1609± .0819	.4125± .0156	.3246± .0123	2.2154± .0841	1.8226± .0691
Uufau	1923	120	.8618± .0375	.4668± .0203	2.1983± .0957	.4359± .0189	.3356± .0145	2.5108± .1093	2.0212± .0875
All	.....	3,073	.9519± .0082	.5008± .0043	2.4263± .0208	.5347± .0046	.3865± .0033	2.5769± .0221	1.9908± .0171
Appendix (class values)									
Taapurau, S	1923	1	15.35	9.50	62.5	8.50	6.50	76.5	55.5
Taapurau, S	1924	1	15.05	9.70	64.5	8.10	6.30	78.5	53.5

TABLE 108—*Partula tæniata simulans. Inner western series. Statistical description*

Series	Year	No.	Range (class values)											
			Shell						Aperture						Length aperture ÷ length shell, proportions	
			Length		Width		Proportions		Length		Width		Proportions			
			mm.		*mm.*		*p. ct.*		*mm.*		*mm.*		*p. ct.*		*p. ct.*	
Tiaorooro	1923	40	15.65	−19.85	8.3	−10.3	49.5	−57.5	8.3	−10.3	5.7	−7.5	66.5	−76.5	48.5	−58.5
Mouaroa	1924	185	14.45	−17.75	8.3	−10.3	51.5	−62.5	7.7	− 9.5	5.9	−7.5	70.5	−81.5	49.5	−59.5
Faataofe	1923	147	14.45	−17.75	7.7	− 9.7	49.5	−59.5	7.7	− 9.7	5.3	−7.3	66.5	−77.5	50.5	−58.5
Faataofe	1924	43	13.85	−17.45	7.7	− 9.5	50.5	−61.5	7.9	− 9.7	5.5	−6.9	69.5	−75.5	50.5	−58.5
Fanautaata	1923	105	14.16	−18.65	7.9	−10.1	48.5	−59.5	7.9	− 9.9	5.3	−7.1	66.5	−75.5	47.5	−58.5
Roroie	1923	176	14.45	−18.65	7.7	− 9.7	47.5	−58.5	7.5	−10.1	5.3	−6.9	63.5	−76.5	47.5	−58.5
Morioahu east	1923	107	15.05	−19.25	7.9	− 9.9	46.5	−57.5	8.1	−10.1	5.5	−7.1	61.5	−77.5	47.5	−56.5
Morioahu	1923	282	14.45	−19.85	8.1	−10.5	49.5	−60.5	7.5	−10.1	5.3	−7.1	64.5	−78.5	47.5	−57.5
Opunohu west	1907	86	14.45	−18.65	8.1	−10.3	50.5	−59.5	7.5	− 9.7	5.3	−7.3	67.5	−77.5	48.5	−57.5
Opunohu west	1909	219	13.85	−18.35	7.9	− 9.9	49.5	−61.5	7.5	− 9.5	5.1	−6.9	61.5	−78.5	47.5	−59.5
Opunohu west, below pass	1919	118	14.75	−18.95	8.1	− 9.9	47.5	−61.5	7.5	− 9.9	5.7	−7.3	67.5	−78.5	47.5	−57.5
Opunohu west, below pass	1919	201	14.45	−18.05	7.9	− 9.9	49.5	−61.5	7.5	− 9.3	5.5	−7.1	68.5	−80.5	47.5	−56.5
Opunohu west, below Atiati(A)	1923	145	14.15	−17.15	7.9	− 9.7	50.5	−61.5	7.1	− 9.1	5.3	−6.9	68.5	−80.5	48.5	−57.5
Opunohu west, below Atiati(B)	1923	109	14.75	−17.75	8.5	−10.1	51.5	−61.5	7.7	− 9.5	5.9	−7.3	70.5	−81.5	49.5	−57.5
Opunohu west, Vaiarahi	1924	651	12.95	−17.45	7.3	− 9.5	47.5	−63.5	7.1	− 9.3	4.9	−6.7	65.5	−80.5	46.5	−58.5
Tupuna	1923	274	14.15	−18.65	7.9	−10.1	50.5	−61.5	7.5	− 9.9	5.5	−7.1	66.5	−79.5	48.5	−59.5
Vaiana	1923	154	14.75	−18.95	8.3	−10.3	49.5	−60.5	7.9	−10.3	5.7	−7.5	66.5	−78.5	49.5	−58.5
All	....	3,042	12.95	−19.85	7.3	−10.5	46.5	−63.5	7.1	−10.3	4.9	−7.5	61.5	−81.5	46.5	−59.5

TABLE 108—*Partula tæniata simulans. Inner western series. Statistical description*—Continued

Mean value													
Tiaorooro	1923	40	17.3600 ±	0.1006	9.2950 ±	0.0476	53.6000 ±	0.1844	9.2450 ±	0.0554	6.7000 ±	0.0437	71.9750 ±	0.2676	53.9500 ±	0.2274
Mouaroa	1924	185	15.7619 ±	.0313	9.0784 ±	.0173	57.5054 ±	.0994	8.5075 ±	.0182	6.4806 ±	.0138	76.2676 ±	.1215	53.7000 ±	.0862
Faataofe	1923	147	15.9419 ±	.0417	8.7177 ±	.0202	54.5952 ±	.1057	8.6456 ±	.0220	6.2211 ±	.0177	71.8673 ±	.1200	54.0918 ±	.0946
Faataofe	1924	43	15.9361 ±	.0787	8.7558 ±	.0353	54.8721 ±	.2151	8.6721 ±	.0448	6.3418 ±	.0306	72.8023 ±	.1876	54.3838 ±	.2198
Fanautaata	1923	105	16.4614 ±	.0563	8.9228 ±	.0281	54.1857 ±	.1514	8.6924 ±	.0290	6.0486 ±	.0222	70.6333 ±	.1475	52.7381 ±	.1382
Roroie	1923	176	16.4153 ±	.0403	8.7034 ±	.0197	52.9375 ±	.1029	8.6762 ±	.0225	6.1216 ±	.0164	70.5170 ±	.1224	52.7045 ±	.1013
Morioahu east	1923	107	17.0098 ±	.0539	8.9168 ±	.0280	52.3411 ±	.1295	8.9261 ±	.0278	6.3205 ±	.0241	70.8084 ±	.1849	52.2944 ±	.1080
Morioahu	1933	282	16.7914 ±	.0324	9.1816 ±	.0164	54.6134 ±	.0805	8.8355 ±	.0169	6.2944 ±	.0127	70.9929 ±	.0992	52.5071 ±	.0755
Opunohu west	1907	86	16.2361 ±	.0649	8.9697 ±	.0323	55.1279 ±	.1450	8.5813 ±	.0337	6.2233 ±	.0258	72.2791 ±	.1786	52.7674 ±	.1387
Opunohu west	1909	219	16.0609 ±	.0338	8.9082 ±	.0173	55.4772 ±	.1035	8.5602 ±	.0195	6.1994 ±	.0143	71.8333 ±	.1228	53.2306 ±	.0889
Opunohu west, below pass	1919	118	16.5830 ±	.0539	9.0051 ±	.0240	54.3388 ±	.1455	8.6543 ±	.0274	6.3864 ±	.0188	73.6695 ±	.1399	51.9830 ±	.1343
Opunohu west, below pass	1923	201	16.1635 ±	.0316	8.9856 ±	.0158	55.4801 ±	.0945	8.4553 ±	.0165	6.3368 ±	.0137	74.8931 ±	.1081	52.1866 ±	.0896
Opunohu west, below Atiati(A)	1923	145	15.5610 ±	.0399	8.7221 ±	.0201	56.0034 ±	.1184	8.2421 ±	.0232	6.1138 ±	.0172	74.1152 ±	.1374	52.8310 ±	.1073
Opunohu west, below Atiati(B)	1923	109	15.9032 ±	.0356	9.1458 ±	.0210	57.4817 ±	.1318	8.5073 ±	.0213	6.4964 ±	.0171	76.1513 ±	.1390	53.4083 ±	.1185
Opunohu west, Vairahi	1924	651	15.3385 ±	.0195	8.4844 ±	.0098	55.6705 ±	.0587	8.0349 ±	.0099	5.8564 ±	.0081	72.8333 ±	.0628	52.6059 ±	.0490
Tupuna	1923	274	16.1022 ±	.0301	8.9803 ±	.0150	55.7044 ±	.0830	8.6540 ±	.0173	6.3350 ±	.0125	73.0511 ±	.0946	53.6496 ±	.0822
Vaiana	1923	154	16.7802 ±	.0419	9.3039 ±	.0199	55.3838 ±	.1127	8.9715 ±	.0229	6.5467 ±	.0161	72.9870 ±	.1304	53.3442 ±	.0876
All	....	3,042	16.0530 ±	.0115	8.8727 ±	.0056	55.2429 ±	.0293	8.5199 ±	.0062	6.2212 ±	.0048	72.8202 ±	.0352	52.9448 ±	.0242
Standard deviation																
Tiaorooro	1923	40	0.9439 ±	0.0711	0.4461 ±	0.0336	1.7291 ±	0.1304	0.5196 ±	0.0392	0.4099 ±	0.0309	2.5098 ±	0.1892	2.1325 ±	0.1608
Mouaroa	1924	185	.6313 ±	.0221	.3478 ±	.0121	2.0040 ±	.0703	.3670 ±	.0128	.2799 ±	.0097	2.4506 ±	.0859	1.7392 ±	.0609
Faataofe	1923	147	.7496 ±	.0295	.3643 ±	.0143	1.8995 ±	.0747	.3956 ±	.0155	.3186 ±	.0125	2.1574 ±	.0848	1.7013 ±	.0669
Faataofe	1924	43	.7654 ±	.0556	.3432 ±	.0249	2.0912 ±	.1521	.4347 ±	.0317	.2975 ±	.0216	1.8240 ±	.1326	2.1373 ±	.1554
Fanautaata	1923	105	.8555 ±	.0398	.4279 ±	.0198	1.3004 ±	.1070	.4407 ±	.0205	.3370 ±	.0157	2.3927 ±	.1043	2.1000 ±	.0977
Roroie	1923	176	.7929 ±	.0285	.3887 ±	.0139	1.0250 ±	.0727	.4422 ±	.0159	.3229 ±	.0116	2.4085 ±	.0865	1.9924 ±	.0716
Morioahu east	1923	107	.8272 ±	.0381	.4290 ±	.0198	1.9867 ±	.0916	.4263 ±	.0196	.3698 ±	.0170	2.8364 ±	.1307	1.6561 ±	.0763
Morioahu	1923	282	.8077 ±	.0229	.4091 ±	.0116	2.0056 ±	.0569	.4220 ±	.0119	.3173 ±	.0090	2.4714 ±	.0701	1.8812 ±	.0534
Opunohu west	1907	86	.8928 ±	.0459	.4439 ±	.0228	1.9944 ±	.1025	.4640 ±	.0238	.3546 ±	.0182	2.4561 ±	.1263	1.9073 ±	.0981
Opunohu west	1909	219	.7418 ±	.0239	.3790 ±	.0122	2.2714 ±	.0732	.4278 ±	.0138	.3137 ±	.0101	2.6955 ±	.0868	1.9504 ±	.0628
Opunohu west, below pass	1919	118	.8696 ±	.0381	.3879 ±	.0170	2.3469 ±	.1029	.4422 ±	.0194	.3042 ±	.0133	2.2561 ±	.0989	2.1657 ±	.0949
Opunohu west, below pass	1923	201	.6656 ±	.0223	.3330 ±	.0112	1.9862 ±	.0668	.3475 ±	.0116	.2885 ±	.0097	2.2724 ±	.0764	1.8837 ±	.0633
Opunohu west, below Atiati(A)	1923	145	.7118 ±	.0282	.3587 ±	.0142	2.1144 ±	.0837	.4142 ±	.0164	.3079 ±	.0121	2.4530 ±	.0971	1.9157 ±	.0759
Opunohu west, below Atiati(B)	1923	109	.5515 ±	.0252	.3247 ±	.0148	2.0408 ±	.0932	.3306 ±	.0150	.2654 ±	.0121	2.1519 ±	.0983	1.8351 ±	.0838
Opunohu west, Vairahi	1924	651	.7389 ±	.0138	.3704 ±	.0069	2.2205 ±	.0415	.3758 ±	.0070	.3086 ±	.0057	2.3765 ±	.0444	1.8548 ±	.0346
Tupuna	1923	274	.7394 ±	.0213	.3688 ±	.0106	2.0384 ±	.0587	.4252 ±	.0122	.3081 ±	.0088	2.3223 ±	.0669	2.0189 ±	.0581
Vaiana	1923	154	.7721 ±	.0196	.3671 ±	.0141	2.0732 ±	.0797	.4225 ±	.0162	.2979 ±	.0114	2.3992 ±	.0922	1.6122 ±	.0619
All	....	3,042	.9421 ±	.0081	.4559 ±	.0039	2.3957 ±	.0207	.5102 ±	.0044	.3949 ±	.0034	2.8831 ±	.0249	1.9806 ±	.0171

TABLE 109—*Partula tæniata simulans. Eastern and northern series. Statistical description*

Series	Year	No.	Range (class values)											
			Shell						Aperture					
			Length		Width		Proportions		Length		Width		Proportions	
			mm.		*mm.*		*p. ct.*		*mm.*		*mm.*		*p. ct.*	
Outer eastern:														
Hotutea	1907	71	13.55	−18.35	8.3	−10.5	50.5	−62.5	7.7	−10.3	5.5	−7.3	64.5	−77.5
Hotutea	1924	184	13.85	−18.35	8.3	−10.3	50.5	−66.5	7.5	− 9.7	5.5	−7.3	65.5	−79.5
Atiraa	1907	358	14.15	−18.95	8.9	−11.1	53.5	−66.5	7.5	−10.1	5.7	−7.7	68.5	−81.5
Atiraa	1924	200	14.15	−18.95	8.5	−11.5	53.5	−65.5	7.7	−10.5	5.3	−7.7	68.5	−81.5
Vaipua	1924	118	14.75	−18.65	8.7	−10.7	51.5	−62.5	8.5	−10.3	6.1	−7.7	67.5	−79.5
All	.....	931	13.55	−18.95	8.3	−11.5	50.5	−66.5	7.5	−10.5	5.3	−7.7	64.5	−81.5
Inner northern:														
Paopao north	1923	216	14.15	−19.25	8.3	−10.7	51.5	−62.5	7.5	−10.3	5.5	−7.5	66.5	−77.5
Paparoa (low)	1907	170	14.75	−19.25	8.1	−10.5	49.5	−61.5	7.7	−10.9	5.7	−7.9	66.5	−78.5
Paparoa (high)	1909	78	13.85	−18.65	8.3	−10.1	51.5	−60.5	7.9	−10.1	5.9	−7.5	65.5	−77.5
Paparoa (high)	1919	35	13.85	−18.65	8.1	−10.1	50.5	−62.5	7.7	− 9.9	5.7	−7.3	67.5	−77.5
Paparoa (low)	1919	573	14.45	−19.25	7.9	−10.9	49.5	−63.5	7.7	−10.5	5.7	−7.9	67.5	−82.5
Paparoa (high)	1923	90	13.55	−17.75	7.9	− 9.7	50.5	−59.5	7.7	− 9.9	5.5	−7.1	65.5	−74.5
All	.....	1,162	13.55	−19.25	7.9	−10.9	49.5	−63.5	7.5	−10.9	5.5	−7.9	65.5	−82.5
Outer northern:														
Vaiare-Vaipohe	1919	73	14.15	−16.85	7.9	− 9.5	50.5	−61.5	7.9	− 9.7	5.5	−6.7	67.5	−80.5
Vaiare-Vaipohe	1924	155	13.85	−19.25	7.9	− 9.9	49.5	−59.5	7.9	−10.3	5.5	−7.3	65.5	−79.5
All	.....	228	13.85	−19.25	7.9	− 9.9	49.5	−61.5	7.9	−10.3	5.5	−7.3	65.5	−80.5
Combined series	.....	2,321	13.55	−19.25	7.9	−11.5	49.5	−66.5	7.5	−10.9	5.3	−7.9	64.5	−82.5

Series	Year	No.	Length aperture + length shell, proportions
			p. ct.
Outer eastern:			
Hotutea	1907	71	47.5 −62.5
Hotutea	1924	184	48.5 −59.5
Atiraa	1907	358	47.5 −59.5
Atiraa	1924	200	49.5 −59.5
Vaipua	1924	118	49.5 −58.5
All	.....	931	47.5 −62.5
Inner northern:			
Paopao north	1923	216	49.5 −59.5
Paparoa (low)	1907	170	49.5 −59.5
Paparoa (high)	1909	78	50.5 −61.5
Paparoa (high)	1919	35	50.5 −58.5
Paparoa (low)	1919	573	48.5 −59.5
Paparoa (high)	1923	90	52.5 −60.5
All	.....	1,162	48.5 −61.5
Outer northern:			
Vaiare-Vaipohe	1919	73	51.5 −60.5
Vaiare-Vaipohe	1924	155	48.5 −59.5
All	.....	228	48.5 −60.5
Combined series	.....	2,321	47.5 −62.5

TABLE 109—*Partula tæniata simulans. Eastern and northern series. Statistical description*—Continued

			Mean value									
Outer eastern:												
Hotutea	1907	71	16.4528 ± 0.0734	9.3479 ± 0.0355	56.5845 ± 0.2023	9.0859 ± 0.0378	6.3817 ± 0.0301	70.0915 ± 0.1907	55.1197 ± 0.1953			
Hotutea	1924	184	15.9533 ± .0428	9.3467 ± .0217	58.5761 ± .1272	8.6845 ± .0214	6.2022 ± .0168	72.2500 ± .1302	54.2826 ± .0905			
Atiraa	1907	358	16.5910 ± .0275	9.8687 ± .0150	59.3604 ± .0825	8.9156 ± .0156	6.6894 ± .0123	74.9246 ± .0824	53.5894 ± .0683			
Atiraa	1924	200	16.2020 ± .0389	9.7042 ± .0210	60.0050 ± .1068	8.8140 ± .0211	6.5890 ± .0173	74.6650 ± .1164	54.3450 ± .0910			
Vaipua	1924	118	17.1881 ± .0452	9.7186 ± .0234	56.4237 ± .1125	9.3407 ± .0283	6.7881 ± .0215	72.6271 ± .1531	54.1780 ± .1104			
All		931	16.4466 ± .0196	9.6796 ± .0105	58.7599 ± .0584	8.9150 ± .0107	6.5780 ± .0087	73.6826 ± .0634	54.0800 ± .0437			
Inner northern:												
Paopao north	1923	216	16.4569 ± .0379	9.3611 ± .0192	56.8194 ± .0955	8.9065 ± .0196	6.4213 ± .0149	71.9629 ± .0959	54.0695 ± .0881			
Paparoa (low)	1907	170	16.6435 ± .0445	9.3706 ± .0228	55.8764 ± .1171	9.0188 ± .0287	6.6270 ± .0189	73.4 35 ± .1317	54.1117 ± .0910			
Paparoa (high)	1909	78	16.4346 ± .0711	9.1103 ± .0292	55.3590 ± .1616	9.0693 ± .0362	6.5513 ± .0252	72.0769 ± .1744	55.0641 ± .1675			
Paparoa (high)	1919	35	16.2415 ± .1137	9.0715 ± .0560	55.9000 ± .2795	8.9514 ± .0518	6.5400 ± .0432	72.7143 ± .2730	55.1000 ± .2316			
Paparoa (low)	1919	573	16.6699 ± .0236	9.2909 ± .0115	55.6710 ± .0691	9.1164 ± .0134	6.7220 ± .0095	73.6762 ± .0782	54.5314 ± .0560			
Paparoa (high)	1923	90	15.6900 ± .0639	8.6689 ± .0299	55.1666 ± .1468	8.8765 ± .0359	6.2756 ± .0245	70.5888 ± .1560	56.5000 ± .1285			
All		1,161	16.5219 ± .0178	9.2394 ± .0090	55.8615 ± .0477	9.0363 ± .0094	6.6007 ± .0073	72.9544 ± .0547	54.5895 ± .0415			
Outer northern:												
Vaiare-Vaipohe	1919	73	15.2843 ± .0479	8.6397 ± .0250	56.3493 ± .1625	8.5329 ± .0281	6.2206 ± .0232	73.1165 ± .2023	55.4452 ± .1506			
Vaiare-Vaipohe	1924	155	15.9713 ± .0406	8.7193 ± .0216	54.5710 ± .1071	8.8084 ± .0220	6.3800 ± .0190	72.2742 ± .1390	55.0355 ± .1098			
All		228	15.7513 ± .0347	8.6939 ± .0168	55.1404 ± .0969	8.7202 ± .0184	6.3290 ± .0152	72.5439 ± .1159	55.1666 ± .0893			
Combined series		2,321	16.4110 ± .0127	9.3624 ± .0077	56.9532 ± .0405	8.9566 ± .0068	6.5649 ± .0054	73.2062 ± .0394	54.4418 ± .0289			
			Standard deviation									
Outer eastern:												
Hotutea	1907	71	0.9171 ± 0.0519	0.4433 ± 0.0251	2.5273 ± 0.1430	0.4727 ± 0.0267	0.3765 ± 0.0213	2.3829 ± 0.1348	2.4401 ± 0.1381			
Hotutea	1924	184	.8611 ± .0302	.4366 ± .0153	2.5590 ± .0899	.4311 ± .0151	.3378 ± .0119	2.6194 ± .0921	1.8198 ± .0640			
Atiraa	1907	258	.7716 ± .0194	.4227 ± .0106	2.3150 ± .0583	.4432 ± .0110	.3470 ± .0087	2.3107 ± .0582	1.9167 ± .0483			
Atiraa	1924	200	.8168 ± .0275	.4399 ± .0148	2.2405 ± .0755	.4430 ± .0149	.3638 ± .0122	2.4408 ± .0823	1.9081 ± .0643			
Vaipua	1924	118	.7291 ± .0319	.3782 ± .0165	1.8140 ± .0795	.4559 ± .0200	.3469 ± .0152	2.4686 ± .1082	1.7797 ± .0780			
All		931	.8896 ± .0138	.4752 ± .0074	2.6413 ± .0413	.4851 ± .0075	.3934 ± .0061	2.8671 ± .0448	1.9775 ± .0309			
Inner northern:												
Paopao north	1923	216	.8377 ± .0268	.4242 ± .0136	2.1137 ± .0675	.4339 ± .0138	.3293 ± .0105	2.1210 ± .0678	1.9496 ± .0623			
Paparoa (low)	1907	170	.8604 ± .0314	.4409 ± .0161	2.2647 ± .0828	.5558 ± .0203	.3649 ± .0133	2.5460 ± .0931	1.7596 ± .0643			
Paparoa (high)	1909	78	.9318 ± .0503	.3828 ± .0207	2.1166 ± .1143	.4748 ± .0256	.3304 ± .0179	2.2844 ± .1234	2.1932 ± .1185			
Paparoa (high)	1919	35	.9975 ± .0804	.4902 ± .0396	2.4520 ± .1976	.4544 ± .0366	.3790 ± .0305	2.3949 ± .1930	2.0312 ± .1637			
Paparoa (low)	1919	573	.8371 ± .0167	.4089 ± .0081	2.4535 ± .0488	.4780 ± .0095	.3382 ± .0067	2.7746 ± .0553	1.9866 ± .0396			
Paparoa (high)	1923	90	.8991 ± .0452	.4205 ± .0211	2.0656 ± .1038	.5054 ± .0254	.3449 ± .0173	2.1942 ± .1103	1.8074 ± .0908			
All		1,162	.8979 ± .0126	.4558 ± .0063	2.4063 ± .0337	.4752 ± .0066	.3704 ± .0051	2.7604 ± .0384	2.0955 ± .0293			
Outer northern:												
Vaiare-Vaipohe	1919	73	.6066 ± .0339	.3170 ± .0177	2.0585 ± .1149	.3566 ± .0198	.2938 ± .0164	2.5623 ± .1437	1.9081 ± .1065			
Vaiare-Vaipohe	1924	155	.7498 ± .0287	.3991 ± .0153	1.9776 ± .0757	.4072 ± .0155	.3502 ± .0134	2.5665 ± .0983	2.0265 ± .0776			
All		228	.7764 ± .0245	.3767 ± .0119	2.1688 ± .0685	.4122 ± .0130	.3414 ± .0107	2.5952 ± .0819	1.9985 ± .0631			
Combined series			.9106 ± .0090	.5480 ± .0054	2.8963 ± .0286	.4871 ± .0048	.3853 ± .0038	2.8177 ± .0278	2.0675 ± .0204			

TABLE 110—*Partula tæniata simulans. Statistics of tooth-development*

Series	Year	No.	Index					Average
			1	2	3	4	5	
Outer western:								
Pafatu	1907	308	278	29	1	...	...	1.1006
Pafatu	1919	175	172	3	...	...	...	1.0171
Taapurau (D+S)	1923	176	174	2	...	...	...	1.0114
Taapurau (D+S)	1924	793	793	...	...	...	...	1.0000
Maatepua	1924	107	107	...	...	...	...	1.0000
Maraarii	1907	58	56	2	...	...	...	1.0345
Maraarii	1923	476	475	1	...	...	...	1.0021
Varari	1909	73	72	1	...	...	...	1.0139
Varari	1923	476	476	...	...	...	...	1.0000
Moruu	1907	90	90	...	...	...	...	1.0000
Moruu	1909	90	90	...	...	...	...	1.0000
Moruu	1923	242	240	2	...	...	...	1.0082
Uufau	1907	191	180	11	...	...	...	1.0576
Uufau	1923	129	129	...	...	...	...	1.0000
Summary	....	3,384	3,334	49	1	...	...	1.0151
Inner western:								
Tiaorooro	1923	43	38	5	...	...	...	1.1163
Mouaroa	1924	202	189	13	...	...	...	1.0643
Faataofe	1923	163	163	...	...	...	...	1.0000
Faataofe	1924	46	46	...	...	...	...	1.0000
Fanautaata	1923	125	124	1	...	...	...	1.0080
Roroie	1923	207	206	1	...	...	...	1.0048
Morioahu east	1923	116	107	9	...	...	...	1.0776
Morioahu	1923	319	303	16	...	...	...	1.0501
Opunohu west	1907	99	82	17	...	...	...	1.1717
Opunohu west	1909	247	194	53	...	...	...	1.2145
Opunohu west	1919	130	130	...	...	...	...	1.0000
Opunohu west	1923	213	200	13	...	...	...	1.0610
Opunohu, below Atiati, A	1923	149	137	12	...	...	...	1.0805
Opunohu, below Atiati, B	1923	121	112	9	...	...	...	1.0744
Vairahi	1924	682	548	130	4	...	...	.....
Tupuna	1923	289	239	50	...	...	...	.....
Vaiana	1923	195	167	28	...	...	...	.....
Summary	....	3,346	2,985	357	4	...	...	1.1091
Outer eastern:								
Hotutea	1907	88	88	...	...	...	...	1.0000
Hotutea	1924	224	191	32	...	1	...	1.1562
Atiraa	1907	379	228	150	1	...	...	1.4010
Atiraa	1924	227	197	29	...	1	...	1.1409
Vaipua	1924	124	124	...	...	...	...	1.0000
Summary	....	1,042	828	211	1	2	...	1.2102
Inner northern:								
Paopao north	1923	251	237	14	...	...	...	1.0557
Paparoa (low)	1907	220	194	26	...	...	...	1.1182
Paparoa (high)	1909	85	82	5	...	...	...	1.0353
Paparoa (high)	1919	44	44	...	...	...	...	1.0000
Paparoa (low)	1919	663	595	68	...	...	...	1.1025
Paparoa (high)	1923	125	125	...	...	...	...	1.0000
Summary	....	1,388	1,277	111	...	...	...	1.0800
Outer northern:								
Vaiare-Vaipoh	1919	91	91	...	...	...	...	1.0000
Vaiare-Vaipoh	1924	166	166	...	...	...	...	1.0000
Summary	....	257	257	...	...	...	...	1.0000
All	....	9,417	8,681	728	6	2	...	1.0792

TABLE 111—*Partula tæniata simulans. Statistical description of the color classes of illustrative series*

Series	No.	Mean value						
		Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Maraarii, 1923, pallida (upper)	75	16.2500±0.0654	9.7320±0.0365	59.8200±0.1497	8.8600±0.0314	6.5880±0.0255	74.1534±0.1432	54.3934±0.1339
fusca	54	16.3555± .0805	9.8222± .0453	59.9444± .2197	8.9148± .0426	6.7000± .0346	75.0704± .2287	54.2778± .1506
fulva	7	16.1643± .1720	9.5286± .0837	58.6429± .3455	8.6429± .1009	6.3857± .0659	73.6429± .6141	53.3572± .3714
frenata	27	16.3500± .1005	9.6037± .0521	58.7963± .2952	8.8556± .0537	6.5223± .0402	73.5741± .2546	54.1666± .1967
All	163	16.2978± .0432	9.7319± .0248	59.6411± .1149	8.8681± .0236	6.6056± .0184	74.3405± .1137	54.2730± .0878
Maraarii, 1923, pallida (lower)	26	16.7692± .1253	10.1000± .0440	60.0769± .3159	9.1769± .0564	6.8308± .0302	74.3077± .3363	54.8308± .2602
fusca	118	16.5119± .0392	10.0017± .0219	60.4916± .1463	9.2153± .0221	6.8255± .0169	73.9576± .1288	55.6356± .1208
fulva	8	16.5875± .1577	10.2000± .0631	61.5000± .3154	9.2750± .1104	6.8750± .0650	74.5000± .4299	55.8750± .3759
frenata	44	16.5296± .0530	10.1727± .0373	61.4772± .2558	9.3091± .0306	6.8682± .0309	73.5000± .1987	56.1363± .1439
zonata	75	16.5780± .0491	10.0547± .0292	60.5666± .1623	9.2414± .0265	6.8120± .0196	73.6600± .1555	55.6333± .1319
All	271	16.5599± .0267	10.0594± .0149	60.6623± .0941	9.2358± .0146	6.8306± .0110	73.8504± .0857	55.6365± .0749
Varari, 1923, pallida	118	15.9754± .0453	9.5949± .0235	59.9916± .1316	8.6661± .0228	6.4203± .0175	74.0339± .1224	54.0762± .1123
fusca	187	15.8890± .0360	9.5556± .0176	60.0722± .1126	8.5695± .0179	6.3716± .0134	74.2219± .1084	53.8583± .0880
fulva	17	16.0029± .1563	9.5235± .0571	59.5000± .3319	8.6176± .0674	6.3941± .0477	73.9705± .3372	53.6764± .2874
phæa-purpurea	55	15.5837± .0662	9.4564± .0315	60.6454± .1694	8.5436± .0382	6.3145± .0266	73.8818± .2148	54.6091± .1498
frenata	54	15.8389± .0763	9.7037± .0379	61.3155± .1951	8.5815± .0357	6.4555± .0279	75.1666± .2227	53.8333± .1550
All	431	15.8707± .0248	9.5710± .0122	60.2564± .0718	8.5960± .0123	6.3891± .0093	74.2355± .0720	54.0267± .0576
Morioahu, 1923, pallida	59	16.9618± .0740	9.2356± .0380	54.5000± .1778	8.8729± .0412	6.3373± .0321	71.0423± .2085	52.2627± .1595
fusca	84	16.7214± .0554	9.1810± .0310	54.8214± .1446	8.8000± .0300	6.3000± .0231	71.3928± .1759	52.4405± .1491
fulva	119	16.7441± .0494	9.1555± .0232	54.5840± .1266	8.8311± .0242	6.2681± .0176	70.7773± .1525	52.6428± .1088
frenata	19	16.8342± .1409	9.1948± .0727	54.3948± .2604	8.8685± .0747	6.3000± .0541	70.7105± .4128	52.6052± .3172
zonata	1[1]	17.40	8.90	51.50	9.50	6.30	65.50	54.50
All	282	16.7914± .0324	9.1816± .0164	54.6134± .0805	8.8355± .0169	6.2944± .0127	70.9929± .0992	52.5071± .0755

[1]Class values.

TABLE 111—*Partula tæniata simulans. Statistical description of the color classes of illustrative series*—Continued

Series	No.	Mean value						
		Shell			Aperture			Length aperture + length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Vairahi, 1924, pallida	84	15.3607±0.0516	8.5643±0.0269	56.0238±0.1624	8.0976±0.0298	5.8929±0.0226	72.7143±0.1774	52 6428±0.1410
fusca	261	15.2500± .0293	8.5268± .0154	55.9521± .0879	8.0571± .0146	5.8740± .0125	72.9521± .0983	52.6571± .0757
fulva	265	15.1927± .0312	8.4298± .0146	55.3151± .0925	7.9951± .0157	5.8321± .0127	72.8358± .0976	52 4925± .0744
frenata	41	15.1525± .0960	8.4025± .0456	55.4512± .2631	8.0220± .0443	5.0220± .0375	72.3049± .2614	52.9390± .2384
All	651	15.3385± .0195	8.4844± .0098	55.6705± .0587	8.0349± .0099	5.8564± .0081	72.8333± .0628	52.6059± .0490
Atiraa, 1907, pallida	110	16.6209± .0553	9.8527± .0277	59.1273± .1694	8.9582± .0305	6.6891± .0234	74.4818± .1448	53 8182± .1312
fusca	119	16.5248± .0447	9.8479± .0231	59.4916± .1345	8.8614± .0251	6.6748± .0183	75.2143± .1358	53.4748± .1118
fulva	83	16.6078± .0553	9.9385± .0353	59.7168± .1546	8.9747± .0333	6.7337± .0296	74.9819± .1793	53.7771± .1294
frenata	21	16.5643± .0968	9.7476± .0536	58.7857± .2731	8.7857± .0571	6.5953± .0460	75.1190± .3972	52 9762± .2786
zonata	13	16.6915± .1079	9.9769± .0632	59.6538± .4140	8.9923± .0757	6.7461± .0532	74.8846± .3988	53 6538± .3268
lyra	12	16.7750± .1654	9.8333± .0958	58.4167± .4240	8.8000± .0863	6.6333± .0602	75.4166± .3767	52.3333± .4040
All	358	16.5910± .0275	9.8687± .0150	59.3604± .0825	8.9156± .0156	6.6894± .0123	74.9246± .0824	53 5894± .0683
Atiraa, 1924, pallida	61	16.3336± .0630	9.8901± .0415	60.3852± .1763	8.8476± .0412	6.6443± .0329	74.9754± .2285	54.0082± .1576
fusca	68	16.1265± .0689	9.7588± .0317	60.0735± .1883	8.7559± .0340	6.5235± .0281	74.5000± .1724	54.2794± .1548
fulva	41	16.2134± .0952	9.6610± .0449	59.5144± .2522	8.8220± .0474	6.6073± .0419	74.8170± .2937	54.3293± .1931
frenata	16	16.0438± .1382	9.6625± .0633	60.0000± .4215	8.8500± .0740	6.6125± .0571	74.5000± .4130	55.1250± .3090
zonata	9	15.9166± .1328	9.5223± .0777	59.7222± .2956	8.9444± .0786	6.5888± .0429	73.8333± .3179	56.1666± .4370
lyra	5	16.5500± .2744	9.7400± .1167	58.9000± .4901	8.7800± .1052	6.5800± .0818	74.0000± .4624	53.7000± .4091
All	200	16.2020± .0389	9.7042± .0210	60.0050± .1068	8.8140± .0211	6.5890± .0173	74.6650± .1068	54.3450± .0910
Paparoa, 1919, pallida (low)	74	16.8905± .0631	9.4351± .0323	55.6486± .2012	9.1811± .0383	6.7811± .0255	73.9054± .2097	54.1081± .1496
fusca	98	16.6388± .0609	9.3428± .0268	56.1020± .1654	9.0980± .0350	6.7184± .0251	73.7143± .1995	54.5408± .1427
fulva	374	16.6422± .0290	9.2540± .0142	55.5668± .0849	9.1144± .0163	6.7149± .0117	73.6096± .0960	54.6176± .0691
phæa-purpurea[1]	1	15.65	9.10	58.50	8.30	6.50	79.50	52.50
frenata	15	16.7700± .1053	9.1800± .0505	54.6333± .3533	9.1800± .0594	6.7133± .0430	73.0333± .2973	54.6333± .3416
zonata[1]	1	15.65	8.50	54.50	8.50	6.30	72.50	54.50
lyra	10	16.4300± .1317	9.9000± .0689	56.9000± .4494	8.9400± .0969	6.7400± .0533	74.6000± .5599	53.5000± .5599
All	573	16.6699± .0236	9.2909± .0115	55.6710± .0691	9.1164± .0134	6.7220± .0095	73.6762± .0782	54.5314± .0560
Vaiare-Vaipohe, 1924, pallida	48	16.0312± .0660	8.7375± .0422	54.4792± .1931	8.8583± .0342	6.3625± .0353	71.6666± .2770	54.8750± .1993
fusca	49	15.8643± .0717	8.7612± .0359	55.2143± .1887	8.8183± .0383	6.4102± .0314	72.5612± .2145	55.5408± .1674
fulva	34	15.9500± .0734	8.6883± .0408	54.3824± .1918	8.7706± .0481	6.3941± .0401	72.7941± .3067	54.9118± .2332
phæa-purpurea	10	16.3100± .2509	8.6600± .1006	53.2000± .2869	8.7600± .1222	6.3200± .0863	71.4000± .2422	53.7000± .3135
frenata	6	15.9500± .2655	8.6000± .0992	53.8333± .3539	8.9000± .1189	6.3666± .0821	71.3333± .4878	55.6666± .2248
zonata	5	15.7700± .2031	8.6600± .1343	54.9000± .7035	8.6600± .1038	6.3400± .1170	73.5000± .8948	53.9000± .9069
lyra	3	16.2500± .0953	8.6333± .1323	53.1666± .6619	8.5000± .1101	6.3000± .1272	74.1666± .8002	52.5000± .5723
All	155	15.9713± .0406	8.7193± .0216	54.5710± .1071	8.8084± .0220	6.3800± .0190	72.2742± .1390	55.0355± .1098

[1] Class values.

TABLE 112—*Partula tæniata simulans. Statistics of fecundity*

Series	Year	Records	Gravid	Per cent gravid	Eggs	Young	Total contents	Average for gravid	Average for all
Outer western:									
Pafatu	1907	302	219	72.51	316	171	487	2.22	1.61
Pafatu	1919	162	128	79.01	183	86	269	2.10	1.66
Taapurau	1923	168	122	72.62	167	65	232	1.90	1.38
Taapurau	1924	746	475	63.67	499	437	936	1.97	1.25
Maatepua	1924	77	65	84.41	86	63	149	2.29	1.93
Maraarii	1907	58	41	70.70	77	27	104	2.53	1.79
Maraarii	1923	463	356	76.99	562	234	796	2.23	1.72
Varari	1909	65	48	73.84	60	40	100	2.08	1.54
Varari	1923	446	363	81.39	567	344	911	2.51	2.04
Moruu	1907	77	45	58.44	78	37	115	2.55	1.49
Moruu	1909	87	48	55.17	83	35	118	2.46	1.35
Moruu	1923	225	184	81.77	237	213	450	2.45	2.00
Uufau	1907	165	129	78.18	230	74	304	2.35	1.84
Uufau	1923	117	103	88.03	158	114	272	2.64	2.32
Summary		3,158	2,326	73.65	3,303	1,940	5,243	2.25	1.66
Inner western:									
Tiaorooro	1923	40	34	85.00	36	52	88	2.59	2.20
Mouaroa	1924	194	110	56.70	111	90	201	1.83	1.04
Faataofe	1923	159	134	84.27	152	232	384	2.86	2.41
Faataofe	1924	44	35	79.54	62	32	94	2.68	2.14
Fanautaata	1923	115	106	92.17	150	146	296	2.79	2.57
Roroie	1923	203	189	93.10	252	252	504	2.67	2.48
Morioahu east	1923	115	96	83.48	135	135	270	2.81	2.35
Morioahu	1923	312	269	86.22	328	370	698	2.59	2.24
Opunohu west	1907	90	75	83.33	102	78	180	2.40	2.00
Opunohu west	1909	245	204	83.26	260	210	470	2.30	1.92
Opunohu west	1919	62	52	83.87	70	35	105	2.02	1.69
Opunohu west	1923	211	194	91.94	347	224	571	2.94	2.71
Opunohu, below Atiati, A	1923	147	115	78.23	172	88	260	2.26	1.77
Opunohu, below Atiati, B	1923	119	106	89.07	183	115	298	2.81	2.50
Vaiarahi	1924	663	563	84.92	812	471	1,283	2.28	1.93
Tupuna	1923	281	213	75.80	256	280	536	2.52	1.91
Vaiana	1923	175	142	81.14	159	215	374	2.63	2.14
Summary		3,175	2,637	83.05	3,587	3,025	6,612	2.51	2.08
Outer eastern:									
Hotutea	1907	88	57	64.77	97	38	135	2.37	1.53
Hotutea	1924	214	156	72.89	174	145	319	2.04	1.49
Atiraa	1907	360	295	81.94	437	137	574	1.94	1.59
Atiraa	1924	193	133	68.91	140	116	256	1.92	1.33
Vaipua	1924	111	88	79.28	128	90	218	2.48	1.96
Summary		966	729	75.46	976	526	1,502	2.06	1.55
Inner northern:									
Paopao north	1923	236	209	88.56	368	198	566	2.71	2.40
Paparoa (low)	1907	204	157	76.96	229	150	379	2.41	1.86
Paparoa (high)	1909	84	74	88.09	105	73	178	2.40	2.12
Paparoa (high)	1919	42	36	85.71	52	36	88	2.44	2.09
Paparoa (low)	1919	641	590	92.04	819	830	1,649	2,79	2.57
Paparoa (high)	1923	125	110	88.00	185	142	327	2.97	2.62
Summary		1,332	1,176	88.29	1,758	1,429	3,187	2.71	2.39
Outer northern:									
Vaiare-Vaipohe	1919	87	72	82.76	104	63	167	2.32	1.92
Vaiare-Vaipohe	1924	149	133	89.26	178	132	310	2.33	2.08
Summary		236	205	86.86	282	195	477	2.33	2.02
All		8,867	7,073	79.77	9,906	7,115	17,021	2.41	1.92

TABLE 113—*Partula tæniata simulans. Recorded adults and their embryonic contents*

Number of eggs	Number of young					Totals	
	0	1	2	3	4		
0	1,794	276	141	12	....	2,223	
1	1,052	1,530	1,008	65	2	3,657	
2	783	1,308	585	42	1	2,719	9,906
3	132	100	26	3	....	261	eggs
4	4	3	....	....	....	7	
Totals	3,765	3,217	1,760	122	3	8,867 records	
		7,115 young					

Summary	Embryonic contents						
	0	1	2	3	4	5	6
Number of adults=8,867	1,794	1,328	2,454	2,460	754	73	4

TABLE 114—*Partula tæniata simulans. Eastern series. Characters of the egg-capsules*

Series	Year	No.	Clear		Cloudy		Opaque	
			No.	Per cent	No.	Per cent	No.	Per cent
Hotutea	1924	137	32	23.36	53	38.68	52	37.96
Atiraa	1924	110	3	2.73	10	9.09	97	88.18
Vaipua	1924	128	101	78.91	27	21.09	...	.....
Vaiare-Vaipohe	1919	104	64	61.54	26	25.00	14	13.47
Vaiare-Vaipohe	1924	178	9	5.06	6	3.37	163	91.57
Paopao north	1923	368	300	81.52	64	17.39	4	1.09
Paparoa (low)	1907	229	141	61.57	19	8.30	69	30.13
Paparoa (high)	1909	105	62	59.05	35	33.33	8	7.62
Paparoa (high)	1919	52	31	59.61	15	28.85	6	11.54
Paparoa (low)	1919	819	491	59.95	75	9.16	253	30.89
Paparoa (high)	1923	185	5	2.70	2	1.08	178	96.22
All	....	2,415	1,239	51.30	332	13.75	844	34.94

TABLE 115—*Partula tæniata simulans. Summary statistics of apparent heredity of coloration*

Class of parents	Number of young							
	pallida	fusca	fulva	phæa-purpurea	frenata	zonata	lyra	Total
pallida	470	1,136	261	...	...	...	...	1,867
fusca	275	1,573	650	...	...	2	...	2,500
fulva	105	785	929	...	1	...	...	1,820
phæa-purpurea	12	86	125	...	...	...	...	223
frenata	67	319	129	...	5	3	...	523
zonata	8	75	42	...	1	4	...	130
lyra	2	20	25	...	...	4	1	52
Total	939	3,994	2,161	...	7	13	1	7,115

TABLE 116—*Partula tæniata simulans. Comparison of embryonic and adult populations, in percentages*

Color-class	Outer western series		Inner western		Eastern and northern series		Whole series	
	Embryos	Adults	Embryos	Adults	Embryos	Adults	Embryos	Adults
pallida	17.45	41.34	15.40	20.44	6.78	20.73	13.20	28.03
fusca	70.51	31.74	54.56	38.04	46.48	23.85	56.13	31.73
fulva	11.92	6.06	29.97	30.36	45.95	42.43	30.37	25.07
phæa-purpurea	0	8.07	0	2.33	0	0.37	0	3.83
frenata	0.05	10.14	0.03	7.98	0.22	6.51	0.10	8.34
zonata	0.05	2.66	0.03	0.84	0.49	3.09	0.18	2.13
lyra	.....	.....	.....	.....	0.04	3.01	0.01	0.86

TABLE 117—*Partula tæniata striolata. Statistical description*

Series	Year	No.	Range (class values)											
			Shell						Aperture						Length aperture ÷ length shell, proportions
			Length		Width		Proportions		Length		Width		Proportions		
			mm.		*mm.*		*p. ct.*		*mm.*		*mm.*		*p. ct.*		*p. ct.*
Vaiare-Puutu	1907	316	13.25	−17.45	8.7	−10.7	56.5	−68.5	7.3	−9.3	5.3	−7.3	69.5	−83.5	49.5 −58.5
Vaiare-Puutu	1919	221	13.55	−17.15	8.3	−10.5	56.5	−70.5	7.1	−9.1	5.3	−7.1	70.5	−83.5	48.5 −57.5
Vaiare-Vaipohe	1919	28	13.85	−17.75	8.7	−10.3	53.5	−62.5	8.1	−9.9	6.1	−7.5	70.5	−81.5	50.5 −60.5
Vaiare-Vaipohe	1924	127	14.15	−17.75	8.3	−10.3	51.5	−62.5	7.5	−9.7	5.7	−7.5	69.5	−80.5	48.5 −58.5
Vaiare-Faamaariri	1919	286	13.25	−17.15	8.3	−10.5	55.5	−67.5	6.9	−9.1	5.3	−7.1	70.5	−83.5	48.5 −58.5
Vaiare-Faamaariri (A)	1923	510	13.25	−18.05	8.1	−10.1	52.5	−68.5	7.1	−9.5	5.5	−7.1	69.5	−84.5	47.5 −59.5
Vaiare-Faamaariri (B)	1923	477	13.25	−18.05	7.7	−10.1	54.5	−66.5	6.9	−9.1	5.3	−7.1	70.5	−83.5	48.5 −58.5
Vaiare-Faamaariri	1924	519	12.65	−16.55	7.9	− 9.9	54.5	−67.5	6.9	−8.9	5.3	−6.9	69.5	−83.5	47.5 −57.5
Tepu	1907	66	14.45	−17.45	8.9	−10.3	56.5	−69.5	7.7	−8.9	5.7	−6.9	71.5	−82.5	48.5 −56.5
Tepu	1919	372	13.55	−17.45	8.5	−10.7	56.5	−69.5	7.1	−9.3	5.5	−7.3	70.5	−85.5	48.5 −60.5
Temæ	1923	486	13.25	−17.75	8.3	−10.7	54.5	−68.5	7.3	−9.3	5.3	−7.3	68.5	−83.5	48.5 −58.5
Maharepa	1907	541	12.95	−16.85	8.3	−10.7	56.5	−70.5	6.9	−9.3	5.3	−7.1	68.5	−83.5	46.5 −59.5
Maharepa	1923	761	12.35	−16.55	8.1	−10.7	53.5	−68.5	6.7	−9.1	5.1	−6.9	66.5	−86.5	46.5 −58.5
Oroau	1923	140	12.65	−16.85	7.9	−10.7	57.5	−65.5	6.5	−9.1	4.9	−7.1	67.5	−84.5	48.5 −56.5
Farehotu	1924	423	13.55	−17.75	8.5	−10.5	55.5	−68.5	6.9	−9.3	5.3	−7.1	68.5	−86.5	46.5 −57.5
Paraoro, middle,	1909	223	13.25	−16.55	8.1	−10.1	55.5	−68.5	7.1	−8.9	5.3	−7.1	68.5	−83.5	48.5 −59.5
Paraoro, middle	1923	138	12.95	−18.05	8.1	−10.7	53.5	−69.5	6.9	−9.1	5.3	−7.3	69.5	−82.5	48.5 −58.5
Paraoro, south	1923	343	13.25	− 17.15	8.3	−10.3	54.5	−66.5	6.9	−9.1	5.3	−6.9	69.5	−83.5	46.5 −58.5
All	.....	5,977	12.35	−18.05	7.7	−10.7	51.5	−70.5	6.5	−9.9	4.9	−7.7	66.5	−86.5	46.5 −60.5

TABLE 117—*Partula tæniata striolata. Statistical description*—Continued

Series	Year	No.	Mean value							
			Shell			Aperture			Length aperture ÷ length shell, proportions
			Length	Width	Proportions	Length	Width	Proportions	
			mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Vaiare-Puutu	1907	316	15.3756± 0.0268	9.5683± 0.0146	62.1424± 0.0861	8.2431±0.0143	6.4019±0.0121	77.6107± 0.0898	53.4874± 0.0658
Vaiare-Puutu	1919	221	15.1817± .0339	9.4611± .0188	62.2512± .1119	8.0991± .0177	6.2656± .0155	77.2828± .1163	53.2466± .0845
Vaiare-Vaipohe	1919	28	15.8321± .1162	9.2143± .0479	58.2143± .2947	8.7214± .0502	6.5857± .0422	75.4286± .2786	55.0714± .2919
Vaiare-Vaipohe	1924	127	15.8674± .0446	9.0622± .0257	57.0040± .1287	8.6559± .0246	6.4890± .0205	74.9016± .1350	54.3670± .1117
Vaiare-Faamaariri	1919	286	15.1538± .0267	9.2623± .0151	61.1049± .0853	8.0678± .0148	6.1622± .0122	76.2098± .1026	53.1364± .0682
Vaiare-Faamaariri (A)	1923	510	15.0812± .0205	8.9890± .0106	59.5470± .0669	8.0761± .0107	6.2279± .0085	76.9372± .0719	53.3883± .0522
Vaiare-Faamaariri (B)	1923	477	15.0978± .0204	9.0623± .0110	59.9570± .0721	8.0916± .0111	6.2539± .0089	77.2275± .0714	53.4853± .0560
Vaiare-Faamaariri	1924	519	14.6269± .0187	8.8469± .0104	60.9210± .0612	7.7551± .0103	5.9042± .0088	75.9720± .0689	52.9181± .0503
Tepu	1907	66	15.4955± .0535	9.6818± .0275	62.3940± .2120	8.2485± .0281	6.3787± .0227	77.1363± .1865	53.1061± .1393
Tepu	1919	372	15.2766± .0232	9.5833± .0135	62.6720± .0806	8.1747± .0136	6.3511± .0094	77.6290± .0810	53.3791± .0646
Temæ	1923	486	15.4012± .0208	9.4803± .0117	61.5720± .0652	8.1885± .0113	6.2066± .0093	75.7099± .0716	53.0720± .0538
Maharepa	1907	541	14.9153± .0199	9.2978± .0106	62.3217± .0626	7.9544± .0116	6.0956± .0095	76.9639± .0703	52.8567± .0514
Maharepa	1923	761	14.6814± .0147	9.0730± .0089	61.7496± .0547	7.7646± .0086	5.9597± .0072	76.5841± .0610	52.7575± .0443
Oroau	1923	140	15.2315± .0421	9.3814± .0238	61.5714± .1206	8.0285± .0227	6.2515± .0186	77.7785± .1383	52.6285± .0880
Farehotu	1924	423	15.5429± .0211	9.5458± .0113	61.4055± .0595	8.1647± .0117	6.3544± .0093	77.7695± .0786	52.4196± .0555
Paraoro, middle	1909	223	14.9357± .0307	9.1574± .0179	61.2265± .1033	7.9412± .0166	6.0471± .0147	75.9395± .1135	53.1188± .0888
Paraoro, middle	1923	138	14.7695± .0468	9.0015± .0238	60.7681± .1355	7.8493± .0227	6.0015± .0182	76.3116± .1390	53.0635± .1108
Paraoro, south	1923	343	15.0551± .0256	9.0989± .0135	60.3776± .0775	7.9332± .0135	6.0674± .0108	76.3164± .0911	52.6078± .0631
All		5,977	15.0858± .0065	9.2310± .0039	61.1471± .0216	8.0215± .0036	6.1664± .0030	76.7345± .0220	53.0648± .0160

TABLE 117—*Partula tæniata striolata. Statistical description*—Continued

			Standard deviation									
Vaiare-Puutu	1907	316	0.7073 ± 0.0189	0.3854 ± 0.0103	2.2688 ± 0.0601	0.3769 ± 0.0101	0.3184 ± 0.0085	2.3674 ± 0.0635	1.7356 ± 0.0465
Vaiare-Puutu	1919	221	.7481 ± .0240	.4143 ± .0133	2.4672 ± .0791	.3915 ± .0125	.3428 ± .0109	2.5646 ± .0822	1.8639 ± .0597
Vaiare-Vaipohe	1919	28	.9118 ± .0821	.3758 ± .0339	2.3123 ± .2084	.3940 ± .0355	.3313 ± .0298	2.1862 ± .1970	2.2902 ± .2064
Vaiare-Vaipohe	1924	127	.7458 ± .0315	.4301 ± .0182	2.1513 ± .0910	.4121 ± .0174	.3435 ± .0145	2.2562 ± .0954	1.8671 ± .0790
Vaiare-Faamaariri	1919	286	.6705 ± .0189	.3802 ± .0107	2.1405 ± .0603	.3722 ± .0104	.3073 ± .0086	2.5726 ± .0725	1.7099 ± .0482
Vaiare-Faamaariri (A)	1923	510	.6861 ± .0145	.3544 ± .0075	2.2413 ± .0473	.3603 ± .0075	.2966 ± .0060	2.4081 ± .0518	1.7593 ± .0369
Vaiare-Faamaariri (B)	1923	477	.6627 ± .0144	.3574 ± .0078	2.3360 ± .0510	.3606 ± .0078	.2894 ± .0063	2.3133 ± .0505	1.8147 ± .0396
Vaiare-Faamaariri	1924	519	.6326 ± .0132	.3524 ± .0073	2.0688 ± .0433	.3471 ± .0073	.2947 ± .0062	2.3274 ± .0487	1.7002 ± .0355
Tepu	1907	66	.6444 ± .0378	.3316 ± .0194	2.5532 ± .1499	.3381 ± .0198	.2740 ± .0160	2.2471 ± .1319	1.6777 ± .0985
Tepu	1919	372	.6626 ± .0164	.3855 ± .0095	2.3041 ± .0570	.3895 ± .0096	.2982 ± .0066	2.3163 ± .0573	1.8488 ± .0457
Temæ	1923	486	.6821 ± .0147	.3825 ± .0083	2.1317 ± .0461	.3700 ± .0080	.3045 ± .0066	2.3415 ± .0506	1.7592 ± .0380
Maharepa	1907	541	.6871 ± .0141	.3652 ± .0075	2.1594 ± .0442	.4009 ± .0082	.3283 ± .0067	2.4258 ± .0504	1.7738 ± .0363
Maharepa	1923	761	.6018 ± .0104	.3653 ± .0063	2.2395 ± .0387	.3553 ± .0061	.2941 ± .0051	2.4964 ± .0431	1.8133 ± .0313
Oroau	1923	140	.7393 ± .0297	.4181 ± .0168	2.0165 ± .0853	.3979 ± .0160	.3259 ± .0131	2.4262 ± .0978	1.5438 ± .0622
Farehotu	1924	423	.6436 ± .0149	.3437 ± .0080	2.1195 ± .0491	.3587 ± .0083	.2848 ± .0066	2.3965 ± .0556	1.6922 ± .0392
Pararo middle	1909	223	.6808 ± .0217	.3966 ± .0126	2.2869 ± .0730	.3679 ± .0117	.3268 ± .0104	2.5136 ± .0802	1.9668 ± .0628
Paraoro middle	1923	138	.8158 ± .0331	.4144 ± .0168	2.3607 ± .0958	.3964 ± .0160	.3178 ± .0128	2.4214 ± .0983	1.9304 ± .0783
Paraoro south	1923	343	.7032 ± .0181	.3722 ± .0095	2.1277 ± .0548	.3718 ± .0095	.2983 ± .0076	2.5009 ± .0644	1.7326 ± .0446
All	.....	5,977	.7460 ± .0046	.4439 ± .0027	2.4814 ± .0183	.4157 ± .0025	.3458 ± .0021	2.5228 ± .0155	1.8320 ± .0113

TABLE 118—*Partula tæniata striolata. Statistics of tooth development*

Series	Year	No.	Index					Average
			1	2	3	4	5	
Vaiare-Puutu	1907	343	201	141	1	....	....	1.4169
Vaiare-Puutu	1919	236	127	108	1	....	....	1.4661
Vaiare-Vaipohe	1919	35	26	9	....	....	....	1.2571
Vaiare-Vaipohe	1924	130	118	12	....	....	....	1.0923
Vaiare-Faamaariri	1919	297	134	163	....	....	....	1.5488
Vaiare-Faamaariri, A	1923	575	278	297	....	....	....	1.5166
Vaiare-Faamaariri, B	1923	525	256	267	2	....	....	1.4914
Vaiare-Faamaariri	1924	607	385	222	....	....	....	1.3657
Tepu	1907	70	53	17	....	....	....	1.2428
Tepu	1919	421	229	185	7	....	....	1.4727
Temæ	1923	499	242	257	....	....	....	1.5150
Maharepa	1907	583	410	170	3	....	....	1.3019
Maharepa	1923	889	526	362	1	....	....	1.4072
Oroau	1923	156	61	95	....	....	....	1.6090
Farehotu	1924	459	259	200	....	....	....	1.4357
Paraoro middle	1909	259	129	127	3	....	....	1.5135
Paraoro middle	1923	142	86	56	....	....	....	1.3944
Paraoro south	1923	358	225	133	....	....	....	1.3715
Summary	.....	6,584	3,745	2,821	18	....	....	1.4339

TABLE 119—*Partula tæniata striolata. Vaiare Valley. Statistical description of the color classes*

Series	No.	Mean value						
		Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Puutu, 1907, pallida	45	15.3034±0.0645	9.5756±0.0377	62.5444±0.2388	8.2156±0.0385	6.3889±0.0307	77.7444±0.2235	53.5444±0.1735
fusca	159	15.4198± .0376	9.5994± .0217	62.1541± .1192	8.2736± .0201	6.4258± .0176	77.5943± .1211	53.5629± .0907
fulva	82	15.3281± .0516	9.5122± .0266	61.9391± .1591	8.2098± .0274	6.3586± .0232	77.3781± .1962	53.3903± .1351
phæa-purpurea	2	15.4400± .2861	9.9000± .2023	60.5000± .0	8.5000± .0954	6.7000± .0954	79.0000± .2384	52.0000± .2384
lyra	28	15.3179± .1034	9.5214± .0405	62.1429± .3341	8.1929± .0484	6.3929± .0350	78.0714± .2939	53.3572± .2200
All	316	15.3756± .0268	9.5683± .0146	62.1424± .0861	8.2431± .0143	6.4019± .0121	77.6107± .0895	53.4174± .0658
Puutu, 1919, pallida	30	15.3800± .0800	9.5911± .0458	62.2000± .2829	8.1911± .0449	6.4000± .0380	78.1000± .2652	53.1333± .1760
fusca	121	15.1499± .0484	9.4620± .0268	62.4339± .1548	8.0868± .0247	6.2389± .0216	77.0703± .1571	53.2686± .1215
fulva	48	15.1500± .0723	9.3666± .0352	61.7709± .2365	8.0584± .0351	6.2000± .0305	76.9584± .2473	53.1042± .1718
phæa-purpurea[1]	1	14.75	9.50	63.50	8.30	6.50	77.50	56.50
zonata[1]	1	16.55	9.70	58.50	8.70	6.50	74.50	52.50
lyra	20	15.1100± .0791	9.4700± .0627	62.5000± .3372	8.1100± .0607	6.3600± .0505	78.2500± .3841	53.5000± .2766
All	221	15.1817± .0339	9.4611± .0188	62.2512± .1119	8.0991± .0177	6.2656± .0155	77.2828± .1163	53.2466± .0845
Vaipohe, 1919, pallida	2	15.3500± .1431	8.9000± .0	57.5000± .4769	8.6000± .0477	6.4000± .0477	74.0000± .2384	56.0000± .5008
fusca	5	15.7700± .2260	9.3400± .0703	59.1000± .3619	8.6200± .1571	6.6600± .1590	77.3000± .6850	54.5000± .5396
fulva	17	15.9500± .1336	9.2059± .1411	57.7941± .3998	8.7353± .1407	6.5589± .0424	74.8530± .3316	54.2059± .3958
zonata	3	15.3500± .5982	9.3000± .2772	60.5000± .6359	8.9000± .2772	6.8333± .1943	76.8333± .4857	57.5000± .3179
lyra[2]	1	16.55	9.10	55.50	8.70	6.60	74.50	53.50
All	28	15.8321± .1162	9.2143± .0470	58.2143± .2947	8.7214± .0502	6.5857± .0432	75.4286± .2786	55.0714± .1910
Vaipohe, 1914, pallida	16	15.5750± .1258	8.9625± .0751	57.6250± .3090	8.5625± .0732	6.5375± .0622	76.5000± .2149	54.9250± .2313
fusca	46	15.8131± .0748	9.0348± .0404	57.1087± .1906	8.6044± .0370	6.4174± .0277	74.5000± .1877	52.2609± .1724
fulva	59	15.9957± .0641	9.0865± .0388	56.5678± .2044	8.7169± .0381	6.5135± .0313	74.6356± .2067	54.1949± .1795
frenata	2	16.1000± .2146	9.4000± .0477	58.5000± .4769	8.7000± .0954	6.6000± .0477	76.0000± .2384	54.5000± .0
zonata	2	15.6500± .2861	9.4000± .1908	60.0000± .2384	8.9000± .1908	6.9000± .2861	76.5000±1.9077	57.5000± .0
lyra	2	15.6500± .0826	9.1000± .0	58.2000± .2384	8.5000± .0	6.5000± .1908	76.5000±1.9077	54.0000± .2384
All	127	15.8674± .0446	9.0622± .0257	57.0040± .1287	8.6559± .0246	6.4890± .0205	74.9016± .1350	54.3670± .1117

[1] Class values.

TABLE 119—*Partula tæniata striolata. Vaiare Valley. Statistical description of the color classes*—Continued

Faamaariri, 1919, pallida	35	15.0928 ± .0873	9.2771 ± .0480	61.5285 ± .2490	8.0543 ± .0523	6.1343 ± .0409	76.0715 ± .2836	53.3286 ± .1974
fusca	133	15.1380 ± .0402	9.2414 ± .0217	61.0188 ± .1214	8.0684 ± .0218	6.1511 ± .0178	76.1091 ± .1462	53.2218 ± .1023
fulva	95	15.1952 ± .0406	9.3000 ± .0266	61.1316 ± .1472	8.0684 ± .0238	6.1968 ± .0214	76.5947 ± .1810	52.9527 ± .1148
phæa-purpurea	2	15.2000 ± .0715	9.3000 ± .0	61.0000 ± .2384	8.1000 ± .0954	6.0000 ± .0477	73.0000 ± .1923	53.0000 ± .2384
frenata[1]	2	15.0500 ± .0	9.0000 ± .0477	59.5000 ± .4769	7.9000 ± .0954	6.0000 ± .0477	75.5000 ± 1.4308	52.0000 ± .2384
zonata	1	15.05	8.70	57.50	8.10	6.00	72.50	53.50
lyra	18	15.1833 ± .1254	9.2445 ± .0528	61.1666 ± .3965	8.1000 ± .0571	6.1666 ± .0318	75.9333 ± .3930	53.2223 ± .2692
All	286	15.1538 ± .0267	9.2623 ± .0151	61.1049 ± .0853	8.0678 ± .0148	6.1622 ± .0122	76.2098 ± .1026	53.1364 ± .0682
Faamaariri A, 1923, pallida	21	15.0786 ± .1187	9.0238 ± .0619	59.7380 ± .3176	8.0143 ± .0571	6.2048 ± .0468	77.3571 ± .3642	52.8333 ± .1720
fusca	127	15.0311 ± .0411	9.0071 ± .0211	59.8701 ± .1260	8.0449 ± .0213	6.2370 ± .0179	77.4764 ± .1397	53.3583 ± .1021
fulva	318	15.0887 ± .0261	8.9717 ± .0133	59.4403 ± .0890	8.0786 ± .0135	6.2189 ± .0112	76.7547 ± .0898	53.3931 ± .0677
phæa-purpurea	3	15.5000 ± .3611	9.3000 ± .0636	59.8333 ± .9178	8.3666 ± .0734	6.5000 ± .1101	77.8333 ± .4857	53.8333 ± .9713
frenata	3	15.3500 ± .0953	9.3000 ± .0636	60.8333 ± .3671	8.6333 ± .0367	6.6333 ± .0367	76.1666 ± .9713	56.1666 ± .6618
lyra	38	15.1289 ± .0572	9.0053 ± .0364	59.2105 ± .1483	8.1263 ± .0396	6.2316 ± .0306	76.4211 ± .2014	53.5000 ± .1792
All	510	15.0812 ± .0205	8.9890 ± .0106	59.5470 ± .0669	8.0761 ± .0107	6.2279 ± .0085	76.9372 ± .0719	53.3883 ± .0522
Faamaariri B, 1923, pallida	26	15.1308 ± .0775	9.0846 ± .0463	59.8077 ± .2952	8.1384 ± .0514	6.3307 ± .0426	77.8461 ± .3046	53.5769 ± .2403
fusca	190	15.1226 ± .0336	9.0726 ± .0172	60.0105 ± .1130	8.1305 ± .0179	6.2611 ± .0142	76.9474 ± .1177	53.6737 ± .0880
fulva	205	15.0939 ± .0285	9.0551 ± .0161	59.8853 ± .1039	8.0707 ± .0162	6.2493 ± .0131	77.3342 ± .1015	53.3732 ± .0853
phæa-purpurea[1]	1	14.45	8.90	60.50	7.50	5.90	78.50	51.50
zonata[1]	1	14.45	8.90	62.50	7.90	6.10	78.50	54.50
lyra	54	15.0334 ± .0735	9.0482 ± .0397	60.0555 ± .2354	8.0259 ± .0337	6.2186 ± .0277	77.4630 ± .2269	53.2223 ± .1689
All	477	15.0978 ± .0204	9.0623 ± .0110	59.9570 ± .0721	8.0916 ± .0111	6.2539 ± .0089	77.2275 ± .0714	53.4853 ± .0560
Faamaariri, 1924, pallida	56	14.8250 ± .0493	8.9393 ± .0273	60.2322 ± .1566	7.7964 ± .0295	5.8822 ± .0246	75.1072 ± .2006	52.4464 ± .1715
fusca	248	14.5698 ± .0259	8.8323 ± .0151	60.5403 ± .0872	7.7161 ± .0151	5.6500 ± .0070	75.9395 ± .0974	52.8549 ± .0697
fulva	135	14.6545 ± .0362	8.8511 ± .0204	60.3371 ± .1250	7.8052 ± .0202	5.9503 ± .0285	76.1296 ± .1396	53.1666 ± .1004
phæa-purpurea	46	14.5805 ± .0711	8.8000 ± .0354	60.2826 ± .2354	7.7391 ± .0307	5.9869 ± .0175	76.7174 ± .2461	52.9565 ± .1756
zonata	5	14.9300 ± .2780	9.0200 ± .1407	60.5000 ± .1907	7.9000 ± .1265	6.1400 ± .0886	76.7000 ± .3518	53.3000 ± .2955
lyra	29	14.6259 ± .0834	8.8173 ± .0472	60.3621 ± .2546	7.7758 ± .0402	5.9345 ± .0348	75.8793 ± .2404	53.0862 ± .1876
All	519	14.6269 ± .0187	8.8469 ± .0104	60.9210 ± .0612	7.7551 ± .0103	5.9042 ± .0088	75.9720 ± .0689	52.9181 ± .0503

[1] Class values.

TABLE 120—*Partula tæniata striolata. Tepu to Paraoro Valleys. Statistical description of the color classes.*

Series	No.	Mean value						
		Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Tepu, 1907, pallida	14	15.4572 ±0.1202	9.7285 ±0.0592	62.7143 ±0.5152	8.3143 ±0.0631	6.3571 ±0.0480	76.2857 ±0.3924	53.5714 ±0.3156
fusca	31	15.5339 ± .0781	9.7064 ± .0505	62.3704 ± .3179	8.2097 ± .0424	6.3775 ± .0362	77.5000 ± .2682	52.7581 ± .2131
fulva	13	15.4885 ± .1198	9.7153 ± .0497	62.8077 ± .4777	8.2385 ± .0556	6.4231 ± .0429	77.9615 ± .4002	53.0385 ± .2899
zonata[1]	1	15.65	9.50	60.50	8.30	6.50	78.50	52.50
lyra	7	15.3929 ± .1606	9.5000 ± .0829	61.3572 ± .1629	8.3000 ± .0817	6.3286 ± .0635	75.5000 ± .3338	53.9285 ± .1857
All	66	15.4955 ± .0535	9.6818 ± .0275	62.3940 ± .2120	8.2485 ± .0281	6.3787 ± .0227	77.1363 ± .1865	53.1061 ± .1393
Tepu, 1919, pallida	60	15.3750 ± .0631	9.6566 ± .0310	62.9166 ± .1962	8.1900 ± .0318	6.3666 ± .0250	77.6833 ± .2211	53.1500 ± .1740
fusca	153	15.2089 ± .0357	9.6150 ± .0199	63.1928 ± .1301	8.1575 ± .0199	6.3562 ± .0144	77.8595 ± .1161	53.4412 ± .1004
fulva	117	15.3269 ± .0396	9.5393 ± .0258	62.0983 ± .1310	8.1752 ± .0252	6.3307 ± .0199	77.3633 ± .1487	53.2778 ± .1118
lyra	42	15.2429 ± .0670	9.4857 ± .0397	62.0238 ± .2169	8.2143 ± .0472	6.3666 ± .0373	77.4524 ± .2744	53.7619 ± .1803
All	372	15.2766 ± .0232	9.5833 ± .0135	62.6720 ± .0806	8.1747 ± .0136	6.3511 ± .0094	77.6290 ± .0810	53.3791 ± .0646
Temæ, 1923, pallida	46	15.4348 ± .0753	9.5261 ± .0388	61.7174 ± .2051	8.2522 ± .0350	6.2522 ± .0305	75.7826 ± .2352	53.3044 ± .1827
fusca	128	15.4062 ± .0431	9.5234 ± .0244	61.7890 ± .1258	8.2000 ± .0233	6.2265 ± .0178	75.7734 ± .1411	53.1172 ± .0952
fulva	238	15.4118 ± .0281	9.4773 ± .0158	61.5000 ± .0921	8.1748 ± .0158	6.1966 ± .0133	75.7605 ± .0836	52.9076 ± .0765
lyra	74	15.3379 ± .0532	9.3865 ± .0293	61.3379 ± .1763	8.1730 ± .0285	6.1756 ± .0243	75.3919 ± .2197	53.3784 ± .1519
All	486	15.4012 ± .0208	9.4803 ± .0117	61.5720 ± .0652	8.1885 ± .0113	6.2066 ± .0093	75.7099 ± .0716	53.0720 ± .0538
Maharepa, 1907, pallida	59	14.9483 ± .0589	9.3169 ± .0330	62.3983 ± .1820	7.9974 ± .0370	6.0898 ± .0293	76.6525 ± .2227	52.9068 ± .1447
fusca	272	14.9314 ± .0271	9.3073 ± .0139	62.1948 ± .0905	7.9684 ± .0154	6.1147 ± .0128	77.0257 ± .1042	52.9338 ± .0743
fulva	115	14.9222 ± .0419	9.2635 ± .0236	62.0391 ± .1325	7.9187 ± .0253	6.0653 ± .0208	76.8826 ± .1482	52.6130 ± .1112
lyra	95	14.8416 ± .0538	9.2811 ± .0281	62.7631 ± .1469	7.9311 ± .0305	6.0811 ± .0248	77.0789 ± .1400	52.9000 ± .1177
All	541	14.9153 ± .0199	9.2978 ± .0106	62.3217 ± .0626	7.9544 ± .0116	6.0956 ± .0095	76.9639 ± .0703	52.8567 ± .0514
Maharepa, 1923, pallida	90	14.7900 ± .0391	9.1155 ± .0246	61.5888 ± .1623	7.8200 ± .0249	5.9333 ± .0198	75.7222 ± .1627	52.7555 ± .1292
fusca	303	14.6253 ± .0238	9.0571 ± .0140	61.8498 ± .0844	7.7218 ± .0130	5.9297 ± .0111	76.6353 ± .0912	52.6617 ± .0668
fulva	254	14.7087 ± .0255	9.0802 ± .0156	61.7126 ± .0974	7.7945 ± .0153	5.9922 ± .0134	76.7362 ± .1113	52.8622 ± .0823
lyra	114	14.6842 ± .0370	9.0649 ± .0237	61.6929 ± .1395	7.7684 ± .0239	5.9877 ± .0176	76.7894 ± .1632	52.7807 ± .1086
All	761	14.6814 ± .0147	9.0730 ± .0089	61.7496 ± .0547	7.7646 ± .0086	5.9597 ± .0072	76.5841 ± .0610	52.7575 ± .0443

[1] Class values.

TABLE 120—*Partula tæniata striolata. Tepu to Paraoro Valleys. Statistical description of the color classes*—Continued

Oroau, 1923, pallida	51	15.2365±0.0657	9.3941±0.0387	61.5588±0.2044	8.0255±0.0366	6.2373±0.0298	77.6372±0.2291	52.5980±0.1568
fusca	50	15.2780± .0767	9.4520± .0408	61.8600± .1943	8.0800± .0402	6.3240± .0299	78.1600± .2357	52.8000± .1431
fulva	24	15.2500± .0779	9.3583± .0431	61.3750± .2224	8.0833± .0380	6.2584± .0493	77.4167± .2693	52.8750± .1813
phæa-purpurea	9	14.7833± .1893	8.9889± .1103	60.6112± .3257	7.7000± .1038	5.8778± .0935	76.2778± .4210	51.7223± .2759
lyra	6	15.2500± .2115	9.3666± .0821	61.5000± .5948	7.9000± .0841	6.3000± .0551	79.5000± .7624	51.8333± .3784
All	140	15.2315± .0421	9.3814± .0238	61.5714± .1206	8.0285± .0227	6.2515± .0186	77.7785± .1383	52.6285± .0880
Farehotu, 1924, pallida	71	15.5782± .0502	9.5958± .0255	61.6267± .1465	8.1760± .0274	6.3479± .0202	77.6831± .1614	52.3733± .1147
fusca	197	15.5297± .0318	9.5416± .0167	61.3883± .1035	8.1609± .0172	6.3721± .0138	78.0025± .1165	52.4442± .0858
fulva	72	15.6292± .0511	9.6055± .0285	61.4445± .1701	8.2250± .0304	6.3777± .0236	77.4861± .2101	52.4167± .1303
phæa-purpurea	29	15.4535± .0778	9.4035± .0439	60.8448± .2637	8.1138± .0455	6.2724± .0382	77.4655± .2641	52.3621± .2296
lyra	54	15.4778± .0544	9.4926± .0276	61.4259± .2081	8.1111± .0305	6.3111± .0248	77.5741± .2268	52.4259± .1507
All	423	15.5429± .0211	9.5458± .0113	61.4055± .0695	8.1647± .0117	6.3544± .0093	77.7695± .0786	52.4196± .0555
Paraoro middle, 1909, pallida	21	14.8072± .0766	9.0524± .0513	61.0715± .3166	7.8715± .0448	5.9666± .0429	75.7857± .3373	53.1666± .2990
fusca	101	14.9342± .0491	9.1891± .0294	61.4208± .1672	7.9712± .0259	6.0782± .0236	75.9554± .1753	53.3118± .1290
fulva	81	14.9796± .0487	9.1296± .0265	60.8704± .1510	7.9247± .0274	6.0136± .0236	75.6851± .1666	52.8580± .1441
phæa-purpurea	7	15.1785± .1408	9.3285± .0880	61.5000± .7210	7.9285± .0573	6.1000± .0667	77.3571± .5561	52.2143± .5895
zonata[1]	1	14.45	9.30	63.50	7.50	6.30	83.50	51.50
lyra	12	14.7750± .1358	9.1500± .0695	61.9166± .3125	7.9666± .0699	6.1000± .0420	76.3333± .4341	53.8333± .3671
All	223	14.9357± .0307	9.1574± .0179	61.2265± .1033	7.9412± .0166	6.0471± .0147	75.9395± .1135	53.1188± .0888
Paraoro middle, 1923, pallida	16	14.7687± .1080	8.9500± .0484	60.5000± .3863	7.8750± .0545	5.9375± .0433	75.3125± .5118	53.0000± .2598
fusca	64	14.6844± .0631	9.0156± .0327	61.2031 .2122	7.8594± .0331	6.0156± .0235	76.3282± .2025	53.4532± .1537
fulva	43	14.8616± .0863	8.9884± .0466	60.1977± .2134	7.8535± .0404	6.0070± .0375	76.4070± .2345	52.7326± .2271
phæa-purpurea	9	14.7167± .1289	8.9889± .0674	61.2777± .4074	7.6556± .0696	5.9445± .0663	77.6111± .4426	52.0556± .1869
zonata[1]	1	15.05	8.70	58.50	7.50	5.70	75.50	50.50
lyra	5	15.1100± .3207	9.1800± .2244	60.5000± .7388	8.0200± .1930	6.1400± .1497	76.3000± .4419	52.9000± .5594
All	138	14.7695± .0468	9.0015± .0338	60.7681± .1355	7.8493± .0227	6.0015± .0182	76.3116± .1390	53.0635± .1108
Paraoro south, 1923, pallida	86	15.1337± .0570	9.1256± .0305	60.3140± .1514	7.9581± .0314	6.0651± .0238	76.1163± .1712	52.5116± .1144
fusca	123	15.0866± .0415	9.1162± .0216	60.2886± .1355	7.9423± .0200	6.1000± .0166	76.6219± .1497	52.5669± .1145
fulva	101	14.9461± .0437	9.0822± .0243	60.7377± .1401	7.9090± .0242	6.0466± .0208	76.2030± .1817	52.8168± .1105
phæa-purpurea	22	14.9818± .0881	8.9909± .0465	60.4500± .2309	7.8273± .0471	5.9909± .0395	76.2728± .3094	52.1818± .2390
zonata	2	15.3500± .0	9.1000± .0954	58.5000± .4769	8.0000± .0477	6.0000± .0477	74.5000± .4769	52.0000± .2384
lyra	9	15.2500± .1799	9.0555± .0661	59.5000± .4973	8.0777± .1026	6.0778± .0447	75.8333± .5805	53.0555± .4254
All	343	15.0561± .0256	9.0989± .0135	60.3776± .0775	7.9332± .0135	6.0674± .0108	76.3164± .0911	52.6078± .0631

[1]Class values.

TABLE 121—*Partula tæniata striolata. Statistics of fecundity*

Series	Year	Records	Gravid	Per cent gravid	Eggs	Young	Total contents	Average for gravid	Average for all
Vaiare-Puutu	1907	282	236	83.68	338	207	545	2.31	1.93
Vaiare-Puutu	1919	164	151	92.07	221	133	354	2.34	2.16
Vaiare-Vaipohe	1919	35	34	97.14	54	34	88	2.59	2.51
Vaiare-Vaipohe	1924	120	106	88.33	148	148	296	2.79	2.47
Vaiare-Faamaariri	1919	280	244	87.14	371	246	617	2.53	2.20
Vaiare-Faamaariri, A	1923	506	480	94.86	872	602	1,474	3.07	2.91
Vaiare-Faamaariri, B	1923	350	328	93.71	550	501	1,051	3.20	3.00
Vaiare-Faamaariri	1924	551	491	89.11	646	535	1,181	2.40	2.14
Tepu	1907	70	60	85.71	83	36	119	1.98	1.70
Tepu	1919	359	277	77.16	303	179	482	1.74	1.34
Temæ	1923	343	310	90.38	387	342	729	2.35	2.13
Maharepa	1907	503	360	71.57	550	182	732	2.03	1.45
Maharepa	1923	791	680	85.97	840	736	1,576	2.31	1.99
Oroau	1923	111	85	76.57	106	53	159	1.87	1.43
Farehotu	1924	447	133	29.75	84	127	211	1.58	0.47
Paraoro middle	1909	246	208	84.55	285	137	422	2.03	1.71
Paraoro middle	1923	116	101	87.07	175	94	269	2.67	2.32
Paraoro south	1923	342	292	85.38	494	217	711	2.43	2.08
Summary		5,616	4,576	81.48	6,507	4,509	11,016	2.41	1.96

TABLE 122—*Partula tæniata striolata. Recorded adults and their embryonic contents*

Number of eggs	Number of young				Totals	
	0	1	2	3		
0	1,040	275	80	2	1,397	
1	661	971	527	21	2,180	
2	545	804	402	46	1,797	6,507
3	81	85	63	7	236	eggs
4	4	....	1	....	5	
5	1	....	....	....	1	
Totals	2,332	2,135	1,073	76	5,616	
		4,509 young				

Summary	Embryonic contents						
	0	1	2	3	4	5	6
Number of adults=5,616	1,040	936	1,596	1,414	512	110	8

TABLE 123—*Partula tæniata striolata. Summary statistics of apparent heredity of coloration*

Class of parents	Number of young							
	pallida	fusca	fulva	phæa-purpurea	frenata	zonata	lyra	Total
pallida	104	264	66	.....	.....	.....	1	435
fusca	196	1,118	355	.....	.....	4	6	1,679
fulva	117	742	753	.....	.....	5	.....	1,617
phæa-purpurea	13	43	56	.....	.....	.....	.....	112
frenata	.....	2	3	.....	.....	.....	.....	5
zonata	1	[illegible]	8	.....	.....	2	.....	19
lyra	26	185	97	.....	.....	73	46	427
Total	457	2,362	1,338	.....	.....	84	53	4,294

TABLE 124—*Partula tæniata striolata. Comparison of embryonic and adult populations, in percentages*

	Color class						
	pallida	fusca	fulva	phæa-purpurea	frenata	zonata	lyra
Embryos	10.64	55.01	31.16	0	0	1.95	1.23
Adults	12.44	41.17	33.58	2.22	0.08	0.29	10.22

TABLE 125—*Partula tæniata nucleola. Statistical description*

Series	Year	No.	Shell			Aperture			Length aperture ÷ length shell, proportions
			Length	Width	Proportions	Length	Width	Proportions	
Range (class values)			*mm.*	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Aareo	1909	50	14.75 −17.45	8.3 − 9.9	52.5 −62.5	7.7 − 9.5	5.5 −7.1	67.5 −78.5	49 5 −57.5
Aareo	1919	60	14.45 −17.75	8.5 −10.1	52.5 −61.5	7.9 − 9.5	5.7 −7.1	68.5 −78 5	50 5 −59 5
Aareo	1923	160	14.15 −17.75	7.9 −10.1	51.5 −62.5	7.5 − 9.7	5.3 −7.1	65 5 −78 5	49 5 −59 5
Urufara	1907	350	13.55 −17.75	8.1 −10.1	50.5 −63.5	7.1 − 9.9	5.1 −7.1	68 5 −82 5	47.5 −57.5
Urufara	1909	256	13.25 −17.75	7.9 −10.7	50.5 −64.5	7.1 − 9.7	5.3 −7.3	67.5 −82 5	47 5 −58 5
Urufara south (A)	1923	89	14.45 −18.05	8.3 − 9.9	53.5 −62.5	7.5 − 9.7	5.5 −7.1	67.5 −79.5	49 5 −59.5
Urufara south (B)	1923	801	12.95 −18.65	7.9 −10.5	49.5 −63.5	7.3 −10.1	5.5 −7.7	67.5 −82 5	48 5 −59 5
Urufara south (C)	1923	205	14.45 −18.65	7.5 −10.1	50.5 −63.5	7.1 −10.1	4.9 −7.1	67.5 −80 5	48 5 −57 5
Urufara north	1923	139	13.85 −18.05	8.3 −10.1	52.5 −64.5	7.3 − 9.3	5.7 −7.9	70.5 −85 5	47 5 −57 5
Urufara north central	1924	99	13.55 −18.05	8.5 −10.1	52.5 −65.5	7.5 − 9.3	5.7 −7.1	71.5 −81 5	48 5 −56 5
Poararua	1923	344	14.15 −20.15	8.5 −10.7	50.5 −65.5	7.7 −10.7	5.9 −7.9	67.5 −83.5	47.5 −59 5
Vaitapi	1923	106	14.45 −18.65	8.9 −10.7	55.5 −65.5	7.9 − 9.9	6.1 −7.7	70.5 −85.5	49 5 −59.5
Vaitapi	1924	45	14.45 −18.05	8.7 −10.5	53.5 −63.5	7.9 − 9.5	6.1 −7.3	72.5 −81.5	49 5 −59.5
Faatoai	1907	221	13.55 −18.05	8.3 −10.1	53.5 −66.5	7.3 − 9.1	5.7 −7.3	70.5 −84 5	48.5 −59 5
Faatoai	1909	263	13.85 −17.75	8.5 −10.5	54.5 −66.5	7.5 − 9.5	5.7 −7.5	71.5 −85.5	48 5 −60 5
Faatoai	1919	771	13.85 −18.05	8.3 −10.5	51.5 −66.5	7.1 − 9.7	5 5 −7.7	69.5 −87 5	47.5 −59.5
Faatoai, Mave	1923 / 1924	314	13.55 −16.85	8.5 −10.3	55.5 −66.5	6.9 − 9.3	5.7 −7.5	73.5 −87.5	48.5 −60 5
Faatoai, Mave upper	1923	133	13.55 −16.85	8.3 −10.3	55.5 −65.5	7.3 − 9.3	5.5 −7.3	70.5 −83.5	49.5 −60 5
Faatoai, Teea	1923	58	14.15 −17.15	8.3 −10.1	55.5 −65.5	7.5 − 9.1	5.7 −7.1	73 5 −84 5	49.5 −58 5
Faatoai, Taatuapæ	1923	459	12.65 −15.65	7.7 − 9.5	54.5 −68 5	6.7 − 8.5	5.1 −6.5	69.5 −84 5	45 5 −57.5
Faatoai, Vaipapa	1924	411	12.35 −16.25	7.7 − 9.7	53.5 −65.5	6.7 − 8.9	5.3 −6.9	71.5 −85.5	48 5 −60.5
Faatoai, Terahimaue	1923	360	13.55 −18.05	8.3 −10.5	54.5 −68.5	7.3 − 9.3	5.5 −7.5	70.5 −86 5	48.5 −58.5
Faatoai, Mataitau	1923	224	13.85 −17.15	8.3 −10.1	55.5 −64.5	7.3 − 9.1	5.7 −7.5	72 5 −86.5	49.5 −60.5
All	....	5,918	12.35 −20.15	7.5 −10.7	49.5 −68.5	6.7 −10.7	4.9 −7.9	65.5 −87.5	45.5 −60.5
Mean value									
Aareo	1909	50	15.8900 ± 0.0689	8.9720 ± 0.0357	56.4200 ± 0.1925	8.4720 ± 0.0395	6.1000 ± 0.0314	71.7000 ± 0.2595	53.2000 ± 0.1621
Aareo	1919	60	16.1100 ± .0621	9.1900 ± .0302	57.0166 ± .1823	8.6100 ± .0322	6.3533 ± .0254	73.8833 ± .1895	53.3666 ± .1648
Aareo	1923	160	15.9687 ± .0431	9.0963 ± .0225	56.8625 ± .1085	8.5775 ± .0225	6.2750 ± .0171	73.1250 ± .1373	53.6125 ± .0994
Urufara	1907	350	15.4657 ± .0280	8.9331 ± .0136	57.7000 ± .0834	8.2280 ± .0151	6.1508 ± .0116	74.5657 ± .0934	53.0114 ± .0674
Urufara	1909	256	15.7883 ± .0357	9.0555 ± .0191	57.3047 ± .1013	8.4094 ± .0192	6.2211 ± .0162	73.8281 ± .1102	53.1366 ± .0847
Urufara south (A)	1923	89	15.7477 ± .0457	9.0798 ± .0254	57.5225 ± .1368	8.4843 ± .0287	6.2394 ± .0221	73.3315 ± .1719	53.7247 ± .1239
Urufara south (B)	1923	801	16.2470 ± .0189	9.2571 ± .0096	56.8508 ± .0531	8.7684 ± .0110	6.5769 ± .0085	74.9445 ± .0587	53.8083 ± .0450
Urufara south (C)	1923	205	16.0832 ± .0369	8.9868 ± .0206	55.7683 ± .1054	8.5499 ± .0233	6.2561 ± .0167	73.2171 ± .1127	52.9878 ± .0938
Urufara north	1923	139	15.8054 ± .0454	9.2799 ± .0238	58.7230 ± .1350	8.3935 ± .0231	6.5575 ± .0202	78.0827 ± .1564	52.1043 ± .1064
Urufara north central	1924	99	15.8258 ± .0487	9.2273 ± .0259	58.2576 ± .1746	8.2212 ± .0246	6.4657 ± .0203	77.1161 ± .1570	52.8232 ± .1255

TABLE 125—*Partula tæniata nucleola. Statistical description*—Continued

Poararua	1923	344	16.2849 ±	0.0294	9.5035 ±	0.0152	58.3168 ±	0.0843	8.7756 ±	0.0162	6.6558 ±	0.0120	75.7703 ±	0.0870	53.7732 ±	0.0693
Vaitapi	1923	106	16.5104 ±	.0516	9.7693 ±	.0263	59.1510 ±	.1544	8.9773 ±	.0250	6.9132 ±	.0233	76.8868 ±	.1699	54.2831 ±	.1420
Vaitapi	1924	45	16.1300 ±	.0726	9.4611 ±	.0356	58.6777 ±	.2184	8.7755 ±	.0332	6.6645 ±	.0303	75.8111 ±	.2041	54.5000 ±	.2150
Faatoai	1907	221	15.2455 ±	.0336	9.1190 ±	.0168	59.8122 ±	.1084	8.1235 ±	.0184	6.3299 ±	.0151	77.9389 ±	.1123	53.1652 ±	.0914
Faatoai	1909	263	15.6055 ±	.0281	9.3775 ±	.0153	60.0167 ±	.0960	8.3851 ±	.0148	6.5631 ±	.0131	78.2263 ±	.1012	53.6825 ±	.0844
Faatoai	1919	771	15.4827 ±	.0166	9.1184 ±	.0089	58.8541 ±	.0551	8.3529 ±	.0095	6.5612 ±	.0076	78.5337 ±	.0610	53.8372 ±	.0488
Faatoai, Mave	1923 1924	314	14.9182 ±	.0244	9.1293 ±	.0130	61.2133 ±	.0782	8.0765 ±	.0144	6.4102 ±	.0120	79.3535 ±	.0953	54.0733 ±	.0474
Faatoai, Mave upper	1923	133	15.1641 ±	.0390	9.1436 ±	.0229	60.1541 ±	.1287	8.1631 ±	.0254	6.3992 ±	.0191	78.3195 ±	.1396	53.6128 ±	.1270
Faatoai, Teea	1923	58	15.2828 ±	.0565	9.1758 ±	.0349	59.9828 ±	.1982	8.1758 ±	.0317	6.3827 ±	.0267	78.0000 ±	.2344	53.3276 ±	.1645
Faatoai, Taatuapæ	1923	459	14.2441 ±	.0190	8.5960 ±	.0101	60.2996 ±	.0696	7.5270 ±	.0103	5.8045 ±	.0092	77.0185 ±	.0781	52.7265 ±	.0552
Faatoai, Vaipapa	1924	411	14.5069 ±	.0168	8.7525 ±	.0109	60.2737 ±	.0702	7.7228 ±	.0121	6.0256 ±	.0097	77.9720 ±	.0832	53.1424 ±	.0591
Faatoai, Terahimaue	1923	360	15.5784 ±	.0273	9.3561 ±	.0154	60.0166 ±	.0759	8.3394 ±	.0141	6.5611 ±	.0130	78.6111 ±	.0854	53.4139 ±	.0653
Faatoai, Mataitau	1923	224	15.1598 ±	.0295	9.2652 ±	.0164	61.0357 ±	.0873	8.2241 ±	.0161	6.5330 ±	.0140	79.3840 ±	.1030	54.1116 ±	.0756
All	....	5,918	15,5166 ±	.0083	9.1269 ±	.0040	58.8043 ±	.0222	8.3216 ±	.0048	6.3876 ±	.0036	76.7374 ±	.0279	53.5149 ±	.0162
			Standard deviation													
Aareo	1909	50	.7225 ±	0.0487	0.3749 ±	0.0252	2.0182 ±	0.1361	0.4138 ±	0.0279	0.3298 ±	0.0222	2.7203 ±	.1835	1.7000 ±	0.1146
Aareo	1919	60	.7131 ±	.0439	.3472 ±	.0213	2.0936 ±	.1289	.3695 ±	.0227	.2918 ±	.0179	2.1763 ±	.1340	1.8927 ±	.1165
Aareo	1923	160	.8082 ±	.0305	.4228 ±	.0159	2.0331 ±	.0767	.4213 ±	.0159	.3215 ±	.0121	2.5733 ±	.0971	1.8641 ±	.0703
Urufara	1907	350	.7795 ±	.0198	.3792 ±	.0096	2.3250 ±	.0590	.4207 ±	.0107	.3240 ±	.0082	2.6019 ±	.0660	1.8788 ±	.0476
Urufara	1909	256	.8476 ±	.0252	.4538 ±	.0135	2.4029 ±	.0716	.4561 ±	.0136	.3851 ±	.0114	2.6134 ±	.0779	2.0089 ±	.0599
Urufara south (A)	1923	89	.6388 ±	.0323	.3560 ±	.0179	1.9137 ±	.0967	.4014 ±	.0203	.3093 ±	.0156	2.4043 ±	.1215	1.7337 ±	.0876
Urufara south (B)	1923	801	.7943 ±	.0133	.4019 ±	.0068	2.2309 ±	.0375	.4606 ±	.0078	.3557 ±	.0060	2.4632 ±	.0415	1.8885 ±	.0318
Urufara south (C)	1923	205	.7847 ±	.0261	.4378 ±	.0145	2.2376 ±	.0745	.4954 ±	.0165	.3548 ±	.0118	2.3927 ±	.0797	1.9917 ±	.0663
Urufara north	1923	139	.7936 ±	.0321	.4164 ±	.0168	2.3599 ±	.0954	.4045 ±	.0163	.3536 ±	.0143	2.7350 ±	.1106	1.8607 ±	.0752
Urufara north central	1924	99	.7186 ±	.0344	.3819 ±	.0183	2.5765 ±	.1234	.3638 ±	.0174	.2996 ±	.0143	2.3169 ±	.1110	1.8522 ±	.0887
Poararua	1923	344	.8093 ±	.0208	.4173 ±	.0107	2.3199 ±	.0596	.4448 ±	.0114	.3315 ±	.0085	2.3918 ±	.0615	1.9065 ±	.0490
Vaitapi	1923	106	.7881 ±	.0365	.4019 ±	.0186	2.3570 ±	.1092	.3812 ±	.0177	.3563 ±	.0165	2.5938 ±	.1201	2.1675 ±	.1004
Vaitapi	1924	45	.7222 ±	.0513	.3544 ±	.0252	2.1735 ±	.1544	.3301 ±	.0235	.3019 ±	.0214	2.0311 ±	.1443	2.1396 ±	.1449
Faatoai	1907	221	.7415 ±	.0237	.3716 ±	.0119	2.3891 ±	.0766	.4064 ±	.0130	.3339 ±	.0107	2.4756 ±	.0794	2.0149 ±	.0646
Faatoai	1909	263	.6763 ±	.0198	.3685 ±	.0108	2.3087 ±	.0679	.3575 ±	.0104	.3155 ±	.0092	2.4326 ±	.0715	2.0294 ±	.0597
Faatoai	1919	771	.6843 ±	.0117	.3677 ±	.0063	2.2675 ±	.0389	.3919 ±	.0067	.3120 ±	.0054	2.5109 ±	.0431	2.0091 ±	.0345
Faatoai, Mave	1923 1924	314	.6405 ±	.0172	.3426 ±	.0092	2.0543 ±	.0553	.3796 ±	.0102	.3155 ±	.0085	2.5055 ±	.0673	1.7619 ±	.0474
Faatoai, Mave upper	1923	133	.6670 ±	.0276	.3927 ±	.0162	2.2006 ±	.0910	.4349 ±	.0179	.3269 ±	.0135	2.3868 ±	.0987	2.1718 ±	.0898
Faatoai, Teea	1923	58	.6377 ±	.0399	.3945 ±	.0247	2.2379 ±	.1401	.3578 ±	.0224	.3018 ±	.0189	2.6474 ±	.1657	1.8582 ±	.1163
Faatoai, Taatuapæ	1923	459	.6056 ±	.0134	.3221 ±	.0071	2.2110 ±	.0492	.3263 ±	.0073	.2914 ±	.0065	2.4829 ±	.0552	1.7452 ±	.0390
Faatoai, Vaipapa	1924	411	.5068 ±	.0119	.3295 ±	.0077	2.1112 ±	.0496	.3647 ±	.0085	.2913 ±	.0068	2.5018 ±	.0585	1.7760 ±	.0418
Faatoai, Terahimaue	1923	360	.7680 ±	.0193	.4324 ±	.0109	2.1356 ±	.0536	.3977 ±	.0096	.3676 ±	.0092	2.4023 ±	.0604	1.8381 ±	.0462
Faatoai, Mataitau	1924	224	.6557 ±	.0208	.3636 ±	.0116	1.9384 ±	.0617	.3582 ±	.0114	.3120 ±	.0099	2.2864 ±	.0728	1.6787 ±	.0534
All	....	5,918	.9541 ±	.0067	.4567 ±	.0032	2.6861 ±	.0157	.5449 ±	.0039	.4168 ±	.0029	3.1803 ±	.0225	1.9599 ±	.0114

TABLE 126—*Partula tæniata nucleola. Condensed statistical description*

Series	No.	Mean values						
		Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Aareo, all	270	15.9833±0.0318	9.0941±0.0166	56.8148±0.0844	8.5652±0.0169	6.2600±0.0134	73.3112±0.0942	53.4815±0.0759
Urufara, all	1,939	15.9520± .0129	9.1354± .0066	57.1864± .0366	8.5400± .0075	6.3966± .0060	74.8079± .0430	53.3845± .0298
Poararua, all	344	16.2849± .0294	9.5035± .0152	58.3168± .0843	8.7756± .0162	6.6558± .0120	75.7703± .0870	53.7732± .0693
Vaitapi, all	151	16.3970± .0434	9.6748± .0227	58.9834± .1269	8.9172± .0207	6.8391± .0197	76.5662± .1366	54.3467± .1186
Faatoai, all	3,214	15.0912± .0098	9.0586± .0053	59.9904± .0273	8.0927± .0058	6.3422± .0049	78.3090± .0305	53.5059± .0230
Whole series	5,918	15.5166± .0083	9.1269± .0040	58.8043± .0222	8.3216± .0048	6.3872± .0036	76.7374± .0279	53.5149± .0162

TABLE 127—*Partula tæniata nucleola. Statistics of tooth development*

Series	Year	No.	Index					Average
			1	2	3	4	5	
Aareo	1909	54	47	7	....	....	....	1.1321
Aareo	1919	78	66	12	....	....	....	1.1538
Aareo	1923	177	159	18	....	....	....	1.1017
Urufara	1907	394	342	50	2	....	....	1.1370
Urufara	1909	296	245	49	2	....	....	1.1790
Urufara south, A	1923	121	111	10	....	....	....	1.0826
Urufara south, B	1923	918	754	164	....	....	....	1.1786
Urufara south, C	1923	219	196	23	....	....	....	1.1050
Urufara north	1923	162	137	25	....	....	....	1.1534
Urufara north central	1924	104	99	5	....	....	....	1.0480
Poararua	1923	454	338	114	1	1	....	1.2621
Vaitapi	1923	120	75	45	....	....	....	1.3750
Vaitapi	1924	60	33	26	1	....	....	1.4666
Faatoai	1907	269	246	23	....	....	....	1.0855
Faatoai	1909	317	292	24	1	....	....	1.0814
Faatoai	1919	886	793	93	....	....	....	1.1049
Faatoai-Mave	1923 1924	338	309	29	....	....	....	1.0858
Faatoai-Mave upper	1923	143	125	18	....	....	....	1.1259
Faatoai-Teea	1923	67	64	3	....	....	....	1.0448
Faatoai-Taatuapæ	1923	500	442	58	....	....	....	1.1160
Faatoai-Vaipapa	1924	444	437	7	....	....	....	1.0157
Faatoai-Terahimaue	1923	391	346	45	....	....	....	1.1151
Faatoai-Mataitau	1923	266	241	25	....	....	....	1.0959
Summary	.....	6,778	5,897	873	7	1	....	1.1313

TABLE 128—*Partula tæniata nucleola. Aareo to Vaitapi Valleys. Statistical description of the color classes*

Series	No.	Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Aareo, 1909, pallida	3	15.9500±0.3244	8.8333±0.0971	55.5000±0.5948	8.4333±0.1600	5.9666±0.0734	70.8333±0.4856	52.5000±0.5507
fusca	22	15.8409± .1045	8.9545± .0536	56.5000± .3141	8.3909± .0536	6.1000± .0541	72.5000± .3950	52.8637± .2794
fulva	19	15.9342± .0869	9.0474± .0626	56.6052± .2651	8.5842± .0588	6.1421± .0498	71.0790± .4119	53.7105± .2164
zonata	3	16.2500± .4371	9.0333± .0971	55.8333± .9713	8.5000± .2293	6.1000± .0636	71.8333±1.2850	52.8333± .1836
lyra	3	15.5500± .2753	8.7000± .0636	56.1666± .8002	8.3666± .0971	5.9666± .0367	70.5000± .5507	53.5000± .6359
All	50	15.8900± .0689	8.9720± .0357	56.4200± .1925	8.4720± .0395	6.1000± .0314	71.7000± .2595	53.2000± .1621
Aareo, 1919, pallida	8	15.7625± .1536	9.1500± .0884	57.5000± .4461	8.5000± .0826	6.2250± .0781	73.5000± .4461	53.1250± .4907
fusca	21	16.2786± .0774	9.2281± .0376	56.6905± .2634	8.6981± .0346	6.3285± .0343	73.8809± .2925	53.5000± .2763
fulva	24	16.1125± .1079	9.1583± .0439	56.9583± .3228	8.5750± .0469	6.4000± .0381	74.7083± .2727	53.0833± .2603
frenata	2	15.3500± .2861	8.8000± .0477	57.0000± .7154	8.4000± .2384	6.1000± .0	73.0000±2.1462	54.5000± .4769
lyra	5	16.1300± .2401	9.4200± .1732	57.9000± .6063	8.7400± .1592	6.5400± .1288	74.1000± .5594	54.1000± .4514
All	60	16.1100± .0621	9.1900± .0302	57.0166± .1823	8.6100± .0312	6.3533± .0254	73.8833± .1895	53.3666± .1648
Aareo, 1923, pallida	25	15.9020± .1229	9.0600± .0615	56.9400± .3125	8.5240± .0508	6.2360± .0386	72.8200± .3674	53.6200± .2331
fusca	40	15.8400± .0886	9.0450± .0442	57.0750± .1947	8.4750± .0491	6.2100± .0344	73.5000± .2489	53.4250± .1972
fulva	70	15.9843± .0612	9.1228± .0333	56.9428± .1587	8.6057± .0332	6.2972± .0256	71.9000± .2143	53.6857± .1450
zonata	8	16.1375± .2084	8.9750± .1214	55.7500± .5932	8.5000± .0674	6.3250± .0906	74.2500± .4421	52.8750± .5324
lyra	17	16.2853± .0980	9.2176± .0550	56.4412± .3097	8.8176± .0594	6.3706± .0472	72.2653± .3909	54.0882± .3274
All	160	15.9687± .0431	9.0963± .0225	56.8625± .1085	8.5775± .0225	6.2750± .0171	73.1250± .1373	53.6125± .0994
Urufara, 1907, pallida	17	15.8088± .1024	8.9000± .0673	56.2059± .3448	8.3117± .0659	6.1470± .0647	73.5583± .3824	52.5000± .3809
fusca	129	15.4166± .0471	8.9155± .0217	57.6001± .1538	8.1915± .0246	6.1574± .0193	75.0271± .1570	52.7558± .1129
fulva	153	15.4872± .0416	8.9732± .0211	57.8398± .1178	8.2477± .0229	6.1588± .0164	74.5000± .1348	53.0553± .0973
phæa-purpurea	36	15.3666± .0681	8.8929± .0403	57.9166± .2024	8.2666± .0501	6.1333± .0425	73.9167± .3345	53.6388± .1952
frenata	9	15.1500± .1854	8.9222± .0685	58.9444± .4384	8.2112± .0831	6.0778± .0651	73.8333± .2596	54.2777± .4074
lyra	6	15.1000± .1614	8.6666± .1074	57.3333± .5823	8.0666± .1074	6.0333± .0757	74.1666± .7400	53.1666± .3434
All	350	15.4657± .0280	8.9331± .0136	57.7000± .0834	8.2280± .0151	6.1508± .0116	74.5657± .0934	53.0114± .0674
Urufara, 1909, pallida	16	15.8187± .1355	9.1750± .0833	57.7500± .3194	8.4000± .0758	6.2625± .0533	74.5000± .3880	52.8125± .2502
fusca	67	15.9142± .0693	9.1060± .0337	57.1717± .1917	8.4612± .0366	6.2791± .0318	74.0970± .2024	55.1672± .1707
fulva	120	15.7750± .0524	9.0217± .0301	57.1584± .1454	8.4066± .0282	6.1866± .0224	73.2333± .1534	53.1750± .1179
phæa-purpurea	41	15.8109± .0796	9.0512± .0513	57.4268± .2499	8.4122± .0441	6.2464± .0389	74.3292± .2771	53.0610± .2244
frenata	8	15.0875± .2356	8.6750± .0996	57.7500± .8660	8.0500± .1137	5.9750± .0890	75.6250± .7068	53.3750± .6245
lyra	4	15.1250± .1102	9.1000± .1652	60.0000± .5592	8.3500± .1870	6.3500± .1295	75.7500±1.1773	54.7500± .7301
All	256	15.7883± .0357	9.0555± .0191	57.3047± .1013	8.4094± .0192	6.2211± .0162	73.9281± .1102	53.1366± .0847
Urufara south, A, 1923, pallida	14	15.7357± .1216	9.0857± .0601	57.7143± .4096	8.3715± .0693	6.1857± .0557	73.6428± .3342	53.0000± .3177
fusca	14	16.0357± .1480	9.2285± .0633	57.5714± .2929	8.6285± .0852	6.3286± .0469	73.2143± .4857	53.7143± .2565
fulva	40	15.7325± .0632	9.0700± .0414	57.4750± .1854	8.5050± .0414	6.2500± .0362	73.3500± .2618	53.9250± .1979
phæa-purpurea	14	15.7357± .0901	8.9715± .0538	56.7143± .3209	8.4572± .0697	6.1572± .0480	72.5714± .2847	53.5714± .2929
frenata	5	15.2900± .0677	9.0200± .0615	58.9000± .6497	8.3800± .0615	6.3400± .0703	75.3000± .7725	54.5000± .2698
zonata	2	15.3500± .1168	9.1000± .0	59.0000± .5841	8.3000± .1557	6.1000± .0	72.0000±1.3629	54.0000± .5841
All	89	15.7477± .0457	9.0798± .0254	57.5225± .1368	8.4843± .0287	6.2394± .0221	73.3315± .1719	53.7247± .1239

TABLE 128—*Partula tæniata nucleola. Aareo to Vaitapi Valleys. Statistical description of the color classes*—Continued

Series	No.	Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Urufara south, B, 1923, pallida	52	16.2442±0.0716	9.2385±0.0412	56.6346±0.1880	8.7346±0.0453	6.5346±0.0349	74.5962±0.2061	53.5192±0.1857
fusca	260	16.3342± .0304	9.2854± .0161	56.7307± .0936	8.8130± .0188	6.6092± .0144	74.9500± .1101	53.7731± .0759
fulva	401	16.1371± .0277	9.2192± .0139	56.9937± .0744	8.7119± .0156	6.5464± .0121	75.0736± .0822	53.8591± .0650
phæa-purpurea	32	16.3812± .0929	9.3437± .0499	56.8750± .2398	8.7875± .0533	6.5875± .0454	75.1563± .2822	53.2500± .1954
frenata	10	16.7000± .1255	9.3200± .0455	56.0000± .5070	8.9800± .0768	6.6200± .0512	73.8000± .4581	53.4500± .4554
zonata	26	16.5269± .1105	9.2923± .0445	56.1923± .3495	8.9538± .0301	6.6307± .0414	73.9231± .3503	54.1154± .2520
lyra	20	16.5200± .1098	9.4800± .0342	57.4000± .3547	9.0300± .0516	6.7700± .0418	74.7500± .3987	54.5500± .2633
All	801	16.2470± .0189	9.2571± .0096	56.8508± .0531	8.7684± .0110	6.5769± .0085	74.9445± .0587	53.8083± .0450
Urufara south, C, 1923, pallida	12	16.1500± .1291	9.0333± .0875	55.8333± .4378	8.6500± .0658	6.3333± .0459	73.2500± .3289	53.2500± .2987
fusca	24	15.9500± .1107	8.8833± .0640	56.3750± .3309	8.3833± .0650	6.1833± .0527	73.8333± .3657	53 0833± .3758
fulva	114	16.1763± .0435	9.0386± .0265	55.7631± .1413	8.6123± .0305	6.3087± .0212	73.3421± .1429	53.0965± .1173
phæa-purpurea	45	16.1166± .0689	8.9311± .0454	55.2778± .2242	8.5044± .0502	6.1888± .0378	72.5223± .2521	52.6333± .1926
frenata	10	15.5900± .1305	8.8400± .0810	56.5000± .2698	8.2200± .1224	6.0400± .0689	73.4000± .5679	52.7000± .4136
All	205	16.0832± .0369	8.9868± .0206	55.7683± .1054	8.5449± .0233	6.2561± .0167	73.2171± .1127	52.9878± .0938
Urufara north, 1923, pallida	20	15.7550± .1034	9.2400± .0427	58.9500± .3144	8.3300± .0598	6.5100± .0350	78.4000± .3871	52.8500± .2709
fusca	31	15.8048± .1060	9.3258± .0608	58.9516± .2714	8.3774± .0535	6.6032± .0539	78.6613± .3344	53.0806± .1840
fulva	55	15.8246± .0751	9.2964± .0379	58.6454± .2169	8.3982± .0360	6.5800± .0317	78.2818± .2535	52.9727± .1662
phæa-purpurea	32	15.8000± .0862	9.2250± .0464	58.4688± .3076	8.4375± .0459	6.4938± .0370	76.9063± .2826	53.5312± .2607
zonata [1]	1	15.95	9.50	59.50	8.50	6.90	80.50	52.50
All	139	15.8054± .0454	9.2799± .0238	58.7230± .1350	8.3935± .0231	6.5575± .0202	78.0827± .1564	53.1043± .1064
Urufara north central, 1924, pallida	6	15.7000± .1299	9.1333± .1074	57.8333± .4401	8.1333± .0866	6.3666± .0936	77.8333± .6868	51.6666± .2938
fusca	14	16.1428± .1425	9.3143± .0764	57.7143± .4778	8.5000± .0528	6.5428± .0548	77.0714± .3837	52.5000± .3914
fulva	42	15.8572± .0790	9.2524± .0421	58.3096± .2343	8.4047± .0412	6.4762± .0343	76.9285± .1955	52.9524± .1805
phæa-purpurea	33	15.7046± .0734	9.1849± .0383	58 4394± .2889	8.3666± .0350	6.4515± .0281	77.1060± .2121	53.1060± .2001
lyra	4	15.5750± .2413	9.1500± .0997	58.7500± .5528	8.1500± .1678	6.3500± .0735	78.2500± .6021	52.0000± .9080
All	99	15.8258± .0487	9.2273± .0259	58.2578± .1746	8.2212± .0246	6.4657± .0203	77.1161± .1570	52.8232± .1255
Poararua, 1923, pallida	48	16.4562± .0703	9.5791± .0368	58.0625± .2380	8.8208± .0389	6 7041± .0316	75.8750± .2245	53.4792± .1952
fusca	139	16.2263± .0489	9.4856± .0258	58.4208± .1316	8.7345± .0263	6.6166± .0197	75.7374± .1404	53.6654± .1112
fulva	154	16.2928± .0427	9.5065± .0211	58.3441± .1233	8.8078± .0239	6.6844± .0170	75.7922± .1286	53.9870± .1014
phæa-purpurea	2	15.6500± .2861	8.8000± .0477	56.0000±1.1923	8.2000± .0477	6.1000± .0954	74.5000± .9539	52.0000±1.1923
lyra [1]	1	16.25	9.30	56.50	8.70	6.50	74.50	53.50
All	344	16.2849± .0294	9.5035± .0152	58.3168± .0843	8.7756± .0162	6.6558± .0120	75.7703± .0870	53.7732± .0693
Vaitapi, 1923, pallida	2	16.5500± .2023	9.3000± .0	56.5000± .4769	8.7000± .0	6.4000± .0477	74.0000± .2384	52.0000± .7154
fusca	31	16.3468± .0859	9.7967± .0468	59.9838± .2784	9.0226± .0491	6.9516± .0394	76.6613± .2702	55.0161± .2784
fulva	72	16.6083± .0626	9.7805± .0318	58.8195± .1766	8.9750± .0291	6.9166± .0287	76.0555± .2172	53.9861± .1584
phæa-purpurea [1]	1	14.45	9.10	62.50	8.30	6.50	77.50	57.50
All	106	16.5104± .0516	9.7698± .0263	59.1510± .1544	8.9773± .0250	6.9132± .0233	76.8868± .1699	54.1831± .1420
Vaitapi, 1924, pallida	2	16.1000± .0715	9.6000± .0477	57.0000± .2384	8.7000± .0	6.7000± .0	76.5000± .4769	54.5000± .0
fusca	11	16.3045± .0931	9.463 ± .0644	58.0455± .3507	8.7545± .0758	6.6637± .0515	75.9545± .3399	53.7728± .3887
fulva	32	16.0719± .0958	9.4375± .0444	58.8125± .2755	8.7875± .0386	6.6675± .0388	75.7187± .2594	54.7500± .2650
All	45	16.1300± .0726	9.4611± .0356	58.6777± .2184	8.7755± .0332	6.6645± .0303	75.8111± .2041	54.5000± .2150

[1] Class values.

TABLE 129—*Partula taeniata nucleola. Faatoai Valley and its subdivisions. Statistical description of the color classes*

Series	No.	Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Faatoai, 1907, pallida	44	15.1250±0.0825	9.1318±0.0395	60.3181±0.2577	8.0637±0.0440	6.3045±0.0314	78.1363±0.1928	53.2273±0.2378
fusca	110	15.1673± .0444	9.0600± .0231	59.7091± .1575	8.0600± .0249	6.2727± .0228	77.8454± .1767	53.0546± .1191
fulva	54	15.5000± .0672	9.2815± .0302	59.9444± .1980	8.3259± .0334	6.4926± .0254	78.0370± .1949	53.5555± .1805
phæa-purpurea	6	15.3000± .2587	8.8666± .1026	58.0000± .5212	8.1666± .0687	6.1666± .0609	75.3333± .5372	53.0000± .6106
zonata	3	15.0500± .0953	8.8333± .0367	59.1666± .3671	7.8333± .0367	6.1666± .0367	78.8333± .9178	51.5000± .3179
lyra	4	15.3500± .1430	9.0000± .0754	58.5000± .5332	7.9500± .1460	6.3500± .0559	80.2500± .6476	51.2500± .1460
All	221	15.2455± .0330	9.1190± .0168	59.8122± .1084	8.1235± .0184	6.3299± .0151	77.9389± .1123	53.1652± .0914
Faatoai, 1909, pallida	46	15.4737± .0620	9.3248± .0370	60.2391± .2208	8.2957± .0355	6.4865± .0282	78.1087± .2854	53.6511± .1901
fusca	151	15.6421± .0369	9.3927± .0190	60.0241± .1252	8.3980± .0182	6.5847± .0164	78.3921± .1249	53.6258± .1050
fulva	52	15.6500± .0662	9.4231± .0372	59.9423± .2196	8.4461± .0402	6.6115± .0331	78.2116± .2315	53.8646± .2232
phæa-purpurea	8	15.3875± .1405	9.3500± .0990	60.6250± .6013	8.4000± .0892	6.5500± .0782	77.8750± .2905	54.5000± .6080
zonata [1]	1	14.45	8.50	59.50	7.70	5.70	74.50	52.50
lyra	5	15.8300± .1949	9.1600± .0241	57.7000± .5849	8.3000± .0763	6.3000± .0381	76.7500± .5592	53.0000± .3694
All	263	15.6055± .0281	9.3775± .0153	60.0167± .0960	8.3851± .0148	6.5631± .0131	78.2263± .1012	53.6825± .0844
Faatoai, 1919, pallida	90	15.5134± .0475	9.1822± .0268	59.3000± .1604	8.3866± .0281	6.5955± .0229	78.6444± .1630	54.0777± .1449
fusca	397	15.4762± .0205	9.1050± .0119	58.7745± .0779	8.3237± .0131	6.5559± .0103	78.7418± .0879	53.6436± .0670
fulva	226	15.4748± .0271	9.1159± .0171	58.8451± .0934	8.3805± .0172	6.5540± .0142	78.2124± .1041	54.0442± .0873
phæa-purpurea	40	15.4775± .0777	9.1650± .0408	59.1000± .2600	8.3850± .0429	6.5800± .0330	78.3750± .2833	54.0750± .2454
frenata [1]	1	16.15	9.30	54.50	8.90	6.90	78.50	51.50
zonata	6	15.4500± .1404	8.8666± .0922	57.1666± .4105	8.2666± .0958	6.3666± .0687	76.7666± .6635	53.1666± .3434
lyra	11	15.5137± .1336	9.0818± .0803	58.6818± .6323	8.4454± .1027	6.6272± .0699	78.3182± .6421	54.3181± .4891
All	771	15.4827± .0166	9.1184± .0080	58.8541± .0551	8.3529± .0095	6.5612± .0076	78.5337± .0610	53.8372± .0488
Mave, 1923, 1924, pallida	87	14.8742± .0426	9.1460± .0235	61.4655± .1560	8.0495± .0285	6.4402± .0234	80.0402± .1846	54.0977± .1881
fusca	111	14.8987± .0369	9.1360± .0202	61.3179± .1310	8.0604± .0202	6.3865± .0183	79.2027± .1529	54.0676± .1066
fulva	80	15.0350± .0533	9.1325± .0299	60.7750± .1430	8.1325± .0331	6.4325± .0263	79.0500± .1808	53.9500± .1161
phæa-purpurea	32	14.8438± .0900	9.0375± .0365	60.9375± .2365	8.0688± .0438	6.3375± .0455	78.4688± .3076	54.2500± .2170
lyra	4	14.6750± .2412	9.2500± .1380	63.2500± .7681	8.0500± .1204	6.5500± .0876	81.2500± .2796	54.7500± .1460
All	314	14.9182± .0244	9.1293± .0130	61.2133± .0782	8.0765± .0144	6.4102± .0120	79.3535± .0953	54.0733± .0670
Mave upper, 1923, pallida	22	15.3364± .0896	9.3000± .0677	60.3182± .3348	8.2182± .0671	6.5000± .0516	78.0484± .4243	54.2727± .2740
fusca	54	15.1667± .0648	9.1333± .0305	60.1481± .2146	8.1222± .0385	6.3740± .0270	78.4074± .2129	53.6296± .1935
fulva	37	15.1068± .0704	9.1649± .0425	60.3648± .2235	8.2297± .0484	6.4189± .0382	78.0675± .2439	54.2027± .2640
phæa-purpurea	16	14.8813± .0902	8.8625± .0622	59.8125± .3304	7.9125± .0577	6.2500± .0484	78.8125± .3023	53.1875± .3139
lyra	4	15.8750± .0839	9.3500± .0292	58.7500± .4381	8.2500± .0292	6.5500± .0559	79.0000± .9976	52.0000± .1686
All	133	15.1651± .0390	9.1436± .0229	60.1541± .1287	8.1631± .0254	6.3992± .0191	78.3195± .1396	53.6128± .1270

[1] Class values.

TABLE 129—*Partula tæniata nucleola. Faatoai Valley and its subdivisions. Statistical description of the color classes*—Continued

Series	No.	Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Teea, 1923, pallida	5	15.5900±0.1330	9.3800±0.1407	60.3000±0.5849	8.2200±0.1242	6.5800±0.0818	80.3000±0.2955	52.5000±0.5047
fusca	18	15.0833± .0965	9.1666± .0540	60.5555± .3156	8.1222± .0435	6.4111± .0385	78.8333± .3930	53.6111± .3628
fulva	25	15.3620± .0887	9.2200± .0512	59.9800± .9172	8.2520± .0492	6.3960± .0368	77.4200± .3812	53.5000± .3078
phæa-purpurea	9	15.1500± .0841	8.9223± .1004	58.9445± .4700	8.0112± .1020	6.1666± .0874	76.8333± .3515	52.9445± .4120
lyra [1]	1	14.15	9.50	57.50	8.50	6.50	76.50	51.50
All	58	15.2828± .0565	9.1758± .0349	59.9828± .1982	8.1758± .0317	6.3827± .0267	78.0000± .2344	53.3276± .1645
Taatuapæ, 1923, pallida	17	14.1147± .0964	8.5588± .0547	60.6176± .3923	7.3941± .0503	5.7823± .0490	77.6764± .3377	55.2647± .2664
fusca	268	14.2742± .0252	8.6283± .0137	60.3657± .0875	7.5425± .0140	5.8209± .0122	77.1157± .1015	52.7052± .0698
fulva	106	14.2179± .0414	8.5434± .0204	60.0661± .1350	7.4812± .0121	5.7528± .0188	76.8491± .1653	52.5188± .1194
phæa-purpurea	66	14.2045± .0467	8.5697± .0234	60.2879± .1646	7.5697± .0254	5.8182± .0235	76.6515± .2154	53.2273± .1463
lyra	2	14.0000± .1669	8.7000± .0954	61.5000± .1431	7.6000± .0477	6.1000± .0954	79.5000± .4769	54.0000± .1192
All	459	14.2441± .0190	8.5980± .0101	60.2996± .0696	7.5270± .0103	5.8045± .0092	77.0185± .0781	52.7265± .0552
Vaipapa, 1924, pallida	90	14.6400± .0411	8.8288± .0226	60.2000± .1526	7.7555± .0261	6.0800± .0197	78.3000± .1902	52.8223± .1208
fusca	152	14.4303± .0320	8.7421± .0171	60.4803± .1058	7.6816± .0177	6.0119± .0150	78.1908± .1252	53.1777± .0977
fulva	113	14.5296± .0407	8.7371± .0229	60.0752± .1247	7.7425± .0233	6.0186± .0204	77.6327± .1647	53.2257± .1185
phæa-purpurea	24	14.4375± .0768	8.7166± .0372	60.5000± .2974	7.7416± .0469	5.9834± .0346	77.7916± .3924	53.5416± .1956
lyra	32	14.4687± .0726	8.6688± .0382	60.0313± .2726	7.7437± .0424	5.9938± .0352	77.3428± .2424	53.2813± .2038
All	411	14.5069± .0168	8.7525± .0109	60.2737± .0702	7.7228± .0121	6.0256± .0097	77.9720± .0832	53.1424± .0591
Terahimaue, 1923, pallida	33	15.5137± .0804	9.4273± .0529	60.5303± .3093	8.3242± .0395	6.6273± .0420	79.4393± .2846	53.5606± .2329
fusca	131	15.6706± .0473	9.3779± .0241	59.8970± .1250	8.3687± .0227	6.5931± .0214	78.7519± .1518	53.6756± .1088
fulva	164	15.5695± .0392	9.3317± .0237	59.8415± .1057	8.3341± .0222	6.5329± .0195	78.3293± .1357	53.3903± .0959
phæa-purpurea	17	15.0324± .0988	9.2177± .0550	61.2059± .1841	8.1941± .0516	6.4765± .0571	78.9706± .2812	54.1470± .2169
zonata	5	15.8300± .1863	9.3400± .1106	59.3000± .7486	8.3000± .1009	6.5400± .1231	77.9000± .8518	52.5000± .6327
lyra	10	15.5300± .1492	9.4800± .0943	61.1000± .5065	8.3600± .0896	6.5400± .0734	78.4000± .4520	53.7000± .3543
All	360	15.5784± .0273	9.3561± .0154	60.0166± .0759	8.3394± .0141	6.5611± .0130	78.6111± .0854	53.4139± .0653
Mataitau, 1923, pallida	34	15.3059± .0852	9.3235± .0384	60.7941± .2393	8.2824± .0370	6.5765± .0323	79.3530± .2784	53.9418± .1951
fusca	92	15.2032± .0489	9.2565± .0277	61.0652± .1421	8.2326± .0263	6.5478± .0241	79.5326± .1591	53.9774± .1259
fulva	74	15.1108± .0450	9.2541± .0257	61.1081± .1407	8.2162± .0275	6.5351± .0211	79.4324± .1667	54.2568± .0640
phæa-purpurea	3	14.7500± .0954	9.3666± .0971	63.1666± .3671	8.1000± .1101	6.5666± .0971	81.8333± .8002	54.5000± .3179
zonata	16	14.9000± .0996	9.0175± .0519	60.6250± .3312	8.0750± .0570	6.6200± .0615	78.0000± .4043	54.2500± .4043
lyra	5	15.1700± .1086	9.2200± .0903	61.1000± .4091	8.3400± .1106	6.3125± .0539	79.1000± .4901	55.1000± .3076
All	224	15.1598± .0195	9.2652± .0164	61.0357± .0873	8.2241± .0161	6.5330± .0140	79.3840± .1030	54.1116± .0765

[1] Class values.

TABLE 130—*Partula tæniata nucleola. Statistics of fecundity*

Series	Year	Records	Gravid	Per cent gravid	Eggs	Young	Total contents	Average for gravid	Average for all
Aareo	1909	52	33	63.46	45	21	66	2.00	1.27
Aareo	1919	76	59	77.63	78	46	124	2.10	1.63
Aareo	1923	164	111	67.68	157	67	224	2.02	1.36
Urufara	1907	377	305	80.90	457	239	696	2.28	1.85
Urufara	1909	232	194	83.62	296	185	481	2.48	2.07
Urufara south, A	1923	118	89	75.42	122	71	193	2.17	1.63
Urufara south, B	1923	827	607	73.39	852	493	1,345	2.22	1.63
Urufara south, C	1923	202	155	76.73	199	166	365	2.35	1.81
Urufara north	1923	161	144	89.44	207	180	387	2.69	2.40
Urufara north central	1924	101	82	81.19	107	79	186	2.27	1.84
Poararua	1923	426	325	76.29	524	178	702	2.16	1.65
Vaitapi	1923	112	96	85.71	193	105	298	3.10	2.66
Vaitapi	1924	49	38	77.55	47	55	102	2.68	2.08
Faatoai	1907	225	177	78.67	296	99	395	2.23	1.75
Faatoai	1909	282	222	78.72	314	200	514	2.31	1.82
Faatoai	1919	306	248	81.04	355	240	595	2.40	1.94
Faatoai, Mave	1923 1924	333	220	66.06	326	121	447	2.03	1.34
Faatoai, Mave upper	1923	139	101	72.66	160	74	234	2.32	1.68
Faatoai, Teea	1923	64	45	70.31	72	53	125	2.77	1.95
Faatoai, Taatuapæ	1923	461	335	72.67	415	407	822	2.63	1.78
Faatoai, Vaipapa	1924	427	324	75.88	487	237	724	2.23	1.69
Faatoai, Terahimaue	1923	367	279	76.02	396	264	660	2.36	1.80
Faatoai, Mataitau	1923	261	126	48.27	166	93	259	2.05	0.99
Summary		5,762	4,315	74.89	6,271	3,673	9,944	2.30	1.73

TABLE 131—*Partula tæniata nucleola. Recorded adults and their embryonic contents*

Number of eggs	Number of young					Totals	
	0	1	2	3	4		
0	1,447	108	45	3	....	1,603	
1	777	847	569	32	....	2,225	6,271 eggs.
2	762	695	285	16	1	1,759	
3	119	41	9	3	....	172	
4	3	....	....	....	....	3	
Totals	3,108	1,691	908	54	1	5,762	
		3,653 young					

Summary	Embryonic contents						
	0	1	2	3	4	5	6
Number of adults=5,762.	1,447	885	1,654	1,386	361	25	4

TABLE 132—*Partula tæniata nucleola. Summary statistics of apparent heredity of coloration*

Class of parents	Number of young							Total
	pallida	fusca	fulva	phæa-purpurea	frenata	zonata	lyra	
pallida	42	265	87	....	....	2	....	396
fusca	58	935	406	....	....	1	1	1,401
fulva	14	585	828	....	....	....	1	1,428
phæa-purpurea	4	89	208	....	....	....	....	301
frenata	....	6	13	....	....	....	1	20
zonata	....	20	23	....	....	....	....	43
lyra	6	49	15	....	....	4	10	84
Total	124	1,949	1,580	....	....	7	13	3,673

TABLE 133—*Partula tæniata nucleola. Comparison of embryonic and adult color classes, in percentages*

	Color Class						
	pallida	fusca	fulva	phæa-purpurea	frenata	zonata	lyra
Embryos	3.37	53.06	43.02	0.	0.	0.19	0.35
Adults	11.86	38.74	37.40	7.74	0.80	1.19	2.26

TABLE 134—*Partula tæniata spadicea. Statistical description*

Series	Year	No.	Shell			Aperture			Length aperture ÷ length shell, proportions
			Length	Width	Proportions	Length	Width	Proportions	
			mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Range (class values)									
Western:									
Uhene	1923	364	12.95 −18.65	8.9 −11.1	56.5 −69.5	7.3 − 9.9	5.7 −7.9	70.5 −85.5	49.5 −60.5
Vaihere	1909	53	14.45 −17.15	8.9 −10.5	57.5 −65.5	7.9 − 9.3	5.9 −7.3	73.5 −83.5	51.5 −57.5
Vaihere	1923	118	13.85 −18.05	8.9 −10.9	57.5 −67.5	7.5 − 9.7	5.9 −7.7	71.5 −84.5	49.5 −58.5
Vaihiaiia north	1924	131	13.55 −16.85	8.5 −10.7	57.5 −68.5	7.3 − 9.3	5.9 −7.5	72.5 −83.5	49.5 −59.5
Vaihiaiia middle	1909	148	12.95 −16.85	8.5 −10.3	54.5 −67.5	7.3 − 9.1	5.5 −7.3	69.5 −84.5	48.5 −59.5
Vaihiaiia south	1923	237	13.55 −17.45	8.5 −10.5	56.5 −67.5	7.3 − 9.1	5.7 −7.1	69.5 −83.5	50.5 −58.5
Matapoopoo	1919	553	13.25 −18.65	7.5 −10.3	49.5 −63.5	7.5 −10.1	5.5 −7.3	65.5 −83.5	46.5 −60.5
Eastern:									
Maahumeru	1919	32	14.75 −17.45	8.7 −10.5	55.5 −65.5	7.7 − 9.1	5.9 −7.1	72.5 −84.5	48.5 −56.5
Punahara	1923	464	14.45 −19.55	8.3 −10.9	52.5 −65.5	7.5 −10.3	5.7 −7.7	68.5 −81.5	46.5 −58.5
Marure	1909	287	13.85 −19.25	9.1 −11.5	54.5 −70.5	7.5 −10.3	6.1 −7.9	70.5 −86.5	48.5 −61.5
Pupuhi-Teviroa	1919	76	14.75 −18.65	8.9 −10.9	54.5 −64.5	7.9 − 9.9	5.9 −7.5	70.5 −80.5	49.5 −58.5
Pupuhi-Teviroa	1923	241	14.45 −18.65	8.9 −11.1	56.5 −66.5	7.5 − 9.7	5.7 −7.7	70.5 −83.5	47.5 −57.5
Summary:									
Western		1,604	12.95 −18.65	7.5 −11.1	49.5 −69.5	7.3 − 9.9	5.5 −7.9	65.5 −85.5	46.5 −60.5
Eastern		1,100	13.85 −19.55	8.3 −11.5	52.5 −70.5	7.5 −10.3	5.7 −7.9	68.5 −86.5	46.5 −61.5
All		2,704	12.95 −19.55	7.5 −11.5	49.5 −70.5	7.3 −10.3	5.5 −7.9	65.5 −86.5	46.5 −61.5
Mean value									
Western:									
Uhene	1923	364	15.8140± 0.0285	10.0038± 0.0152	63.2061± 0.0840	8.6660± 0.0151	6.7923±0.0123	78.3215± 0.0834	54.2198± 0.0703
Vaihere	1909	53	15.9877± .0595	9.8170± .0312	61.7453± .1878	8.6886± .0289	6.7151± .0287	77.6132± .2073	54.5755± .1588
Vaihere	1923	118	15.9551± .0441	9.8831± .0267	61.9152± .1225	8.6560± .0271	6.8153± .0226	78.6271± .1531	54.1356± .1055
Vaihiaiia north	1924	131	15.1278± .0364	9.5839± .0235	63.3015± .1338	8.2817± .0216	6.4878± .0176	78.2939± .1262	54.5916± .1136
Vaihiaiia middle	1909	148	15.0946± .0394	9.3040± .0216	61.5338± .1250	8.1135± .0211	6.2581± .0183	77.0608± .1412	53.6486± .1063
Vaihiaiia south	1923	237	15.2221± .0287	9.4595± .0170	62.0148± .0878	8.3261± .0163	6.3937± .0132	76.7447± .1016	54.5717± .0747
Matapoopoo	1919	553	15.8540± .0226	9.2042± .0118	58.0118± .0626	8.6729± .0128	6.4266± .0091	74.0443± .0750	54.5814± .0566
Eastern:									
Maahumeru	1919	32	15.9313± .0838	9.5562± .0503	59.9063± .2455	8.3687± .0486	6.5312± .0356	78.1562± .3341	52.3750± .2060
Punahara	1923	464	16.2423± .0243	9.6505± .0132	59.3211± .0743	8.6948± .0131	6.5776± .0105	75.5776± .0756	53.4095± .0586
Marure	1909	287	16.5960± .0330	10.0965± .0172	60.7857± .0955	8.8478± .0191	6.8924± .0140	77.8345± .1035	53.1446± .0745
Pupuhi-Teviroa	1919	76	16.5934± .0597	9.8448± .0321	59.2369± .1599	8.9000± .0295	6.7973± .0248	76.2763± .1488	53.9605± .1406
Pupuhi-Teviroa	1923	241	16.0869± .0314	9.8577± .0175	61.4971± .0924	8.6228± .0178	6.6676± .0142	77.3755± .1010	53.4876± .0810
Summary:									
Western		1,604	15.6307± .0137	9.5326± .0088	60.9495± .0524	8.5358± .0077	6.5323± .0063	76.4944± .0518	54.4944± .0325
Eastern		1,100	16.3157± .0162	9.8228± .0093	60.1264± .0498	8.7236± .0090	6.6954± .0073	76.6836± .0535	53.3309± .0381
All		2,704	15.9094± .0112	9.6507± .0067	60.6146± .0375	8.6122± .0060	6.5987± .0048	76.5714± .0377	54.0211± .0257

TABLE 134—*Partula tæniata spadicea. Statistical description*—Continued

Series	Year	Nos.	Shell			Aperture			Length aperture + length shell, proportions
			Length	Width	Proportions	Length	Width	Proportions	
			mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Standard deviation									
Western:									
Uhene	1923	364	0.8070± 0.0202	0.4313± 0.0108	2.3775± 0.0595	0.4272± 0.0107	0.3475±0.0087	2.3588± 0.0590	1.9886± 0 0498
Vaihere	1909	53	.6420± .0421	.3374± .0221	2.0272± .1328	.3118± .0204	.3104± .0202	2.2374± .1466	1.7139± .1123
Vaihere	1923	118	.7115± .0312	.4315± .0189	1.9758± .0866	.4373± .0191	.3649± .0160	2.4686± .1082	1.7007± 0746
Vaihiaiia north	1924	131	.6176± .0257	.3984± .0166	2.2700± .0946	.3677± .0153	.2994± .0124	2.1427± .0892	1.9279± .0803
Vaihiaiia middle	1909	148	.7108± .0278	.3900± .0153	2.2544± .0884	.3818± .0149	.3306± .0129	2.2554± .0884	1.9185± .0751
Vaihiaiia south	1923	237	.6556± .0203	.3889± .0120	2.0034± .0621	.3727± .0115	.3010± .0093	2.3183± .0718	1.7060± .0528
Matapoopoo	1919	553	.7871± .0160	.4107± .0083	2.1842± .0443	.4454± .0090	.3190± .0064	2.6162± .0530	1.9742± .0400
Eastern:									
Maahumeru	1919	32	.7033± .0592	.4220± .0355	2.0594± .1736	.4081± .0343	.2983± .0252	2.8019± .2363	1.7275± .1456
Punahara	1923	464	.7766± .0172	.4207± .0093	2.3718± .0525	.4183± .0092	.3361± .0074	2.4154± .0534	1 8709± .0414
Marure	1909	287	.8282± .0233	.4326± .0121	2.3982± .0675	.4812± .0135	.3526± .0099	2.5998± .0732	1.8720± .0527
Pupuhi-Teviroa	1919	76	.6721± .0422	.4150± .0227	2.0671± .1130	.3811± .0208	.3204± .0175	1.9235± .1052	1 8169± .0994
Pupuhi-Teviroa	1923	241	.7235± .0222	.4021± .0124	2.1273± .0653	.4097± .0126	.3261± .0100	2.3245± .0714	1.8636± .0673
Summary:									
Western		1,604	.8124± .0097	.5219± .0062	3.1127± .0370	.4601± .0054	.3776± .0044	3.0838± .0366	1.9291± .0230
Eastern		1,100	.7983± .0114	.4587± .0066	2.4484± .0352	.4423± .0063	.3616± .0051	2.6332± .0378	1.8739± .0269
All		2,704	.8741± .0079	.5172± .0047	2.8897± .0265	.4629± .0042	.3795± .0035	2.9105± .0266	1.9907± .0182
Appendix									
Vaihiaiia south, S.	1923	1	14.75	9.70	64.50	8.10	6.50	80.50	54.50

TABLE 135—*Partula tæniata spadicea. Statistics of tooth development*

Series	Year	No.	Index					Average
			1	2	3	4	5	
Western:								
Uhene	1923	425	346	79	....	....	....	1.2858
Vaihere	1909	70	42	28	....	....	....	1.4000
Vaihere	1923	128	95	33	....	....	....	1.2578
Vaihiaiia north	1924	144	116	28	....	....	....	1.1944
Vaihiaiia middle	1909	182	128	54	....	....	....	1.2967
Vaihiaiia south, D and S.	1923	287	199	88	....	....	....	1.3066
Matapoopoo	1919	619	501	118	....	....	....	1.1906
Matapoopoo east	1923	1	1	...	....	....	....	1.0000
Eastern:								
Maahumeru	1919	38	27	11	....	....	....	1.2895
Punahara	1923	512	461	51	....	....	....	1.0980
Marure	1909	343	282	61	....	....	....	1.1778
Pupuhi-Teviroa	1919	92	83	9	...	....	....	1.0978
Pupuhi-Teviroa	1923	275	236	39	....	....	....	1.1418
All		3,116	2,517	599	....	....	....	1.1922

TABLE 136—*Partula tæniata spadicea. Western series. Statistical description of the color classes*

Series	No.	Mean value: Shell: Length	Shell: Width	Shell: Proportions	Aperture: Length	Aperture: Width	Aperture: Proportions	Length aperture ÷ length shell, proportions
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Uhene, 1923, pallida	123	15.8061±0.0443	10.0366±0.0252	63.4350±0.1446	8.6740±0.0245	6.7975±0.0205	78.2968±0.1453	54.7601±0.1233
fusca	130	15.7907± .0518	10.0015± .0253	63.3067± .1380	8.6677± .0255	6.7738± .0205	78.1616± .1459	54.8307± .1155
fulva	61	15.6402± .0658	9.9393± .0396	63.4181± .1904	8.5886± .0402	6.7557± .0308	78.5655± .1869	54.8278± .1718
zonata	18	16.3333± .1280	10.0222± .0688	61.4445± .4121	8.7000± .0653	6.8888± .0594	78.6111± .3817	53.3889± .2422
lyra	32	15.9781± .0887	10.0000± .0523	62.5000± .2615	8.7562± .0499	6.8625± .0397	78.4375± .2439	54.7187± .2284
All	364	15.8140± .0285	10.0038± .0152	63.2061± .0840	8.6660± .0151	6.7923± .0123	78.3215± .0834	54.2198± .0703
Vaihere, 1909, pallida	11	15.8581± .1807	9.7000± .0901	61.3182± .3860	8.6818± .0648	6.6637± .0791	77.6818± .4050	55.2272± .3478
fusca	21	16.1071± .0940	9.8905± .0421	61.8809± .3443	8.6905± .0357	6.7666± .0389	77.5476± .3130	54.1191± .2424
fulva	12	15.8000± .0854	9.8500± .0695	62.7500± .2651	8.6500± .0618	6.6834± .0625	77.4167± .4458	54.8333± .3009
zonata	4	15.9000± .0876	9.6500± .0559	61.0000± .5058	8.6500± .0876	6.6000± .1012	79.7500± .8389	54.5000± .7154
lyra	5	16.2900± .1055	9.8200± .0482	60.3000± .2955	8.8200± .0615	6.7800± .0615	76.5000± .5047	54.5000± .4266
All	53	15.9877± .0595	9.8170± .0312	61.7453± .1878	8.6887± .0289	6.7151± .0287	77.6132± .2073	54.5755± .1588
Vaihere, 1923, pallida	29	16.0121± .1027	9.9758± .0490	62.2931± .2191	8.7069± .0666	6.9000± .0558	79.0517± .3249	54.3276± .2612
fusca	49	15.8827± .0684	9.8143± .0423	61.7653± .1925	8.5980± .0393	6.7980± .0335	79.0102± .2353	54.0306± .1534
fulva	18	16.0000± .0944	9.9222± .0484	61.8888± .3899	8.7111± .0554	6.7333± .0322	77.1112± .3715	54.3333± .2962
zonata	6	16.1000± .1299	10.0666± .0587	62.3333± .2471	8.8000± .1090	7.0000± .0885	78.8333± .2596	54.5000± .3554
lyra	16	15.9687± .1151	9.8125± .0705	61.5625± .3119	8.6250± .0683	6.7375± .0599	78.3125± .3764	53.7500± .1520
All	118	15.9551± .0441	9.8831± .0267	61.9152± .1225	8.6560± .0271	6.8153± .0226	78.6271± .1531	54.1356± .1055
Vaihiaiia north, 1924, pallida	29	15.2259± .0774	9.6241± .0540	63.1552± .2757	8.2862± .0526	6.5138± .0410	78.3621± .2563	54.3621± .2455
fusca	53	15.1575± .0556	9.6169± .0353	63.3868± .2316	8.2698± .0342	6.4925± .0283	78.5000± .2106	54.3679± .1955
fulva	25	15.0500± .0715	9.5720± .0539	63.5800± .2470	8.2840± .0444	6.4840± .0388	78.4200± .2016	54.9800± .2196
zonata	10	15.3800± .1443	9.5800± .0744	62.1000± .3719	8.4400± .0384	6.4800± .0554	76.5000± .5224	54.5000± .3984
lyra	14	14.7715± .1109	9.4000± .0664	63.6428± .3185	8.2000± .0678	6.4286± .0444	78.4286± .3570	55.2142± .2402
All	131	15.1278± .0364	9.5839± .0235	63.3015± .1338	8.2817± .0216	6.4878± .0170	78.2939± .1262	54.5916± .1136
Vaihiaiia middle, 1909, pallida	52	15.1451± .0673	9.2693± .0387	61.0577± .2173	8.0539± .0329	6.2231± .0322	77.0962± .2537	52.9423± .1483
fusca	38	15.0895± .0765	9.3632± .0417	62.2368± .2110	8.1947± .0486	6.3158± .0380	77.2368± .3091	54.4210± .2373
fulva	24	15.3625± .0979	9.4416± .0556	61.4166± .3201	8.2500± .0472	6.3583± .0368	76.9584± .3204	53.7916± .2528
zonata	22	14.9000± .0953	9.1728± .0531	61.4546± .2987	8.0364± .0478	6.1909± .0456	76.9091± .3263	53.9545± .2663
lyra	12	14.9500± .1152	9.2333± .0768	61.7500± .4843	7.9834± .0604	6.1500± .0506	76.8333± .3009	53.4166± .2916
All	148	15.0946± .0394	9.3040± .0216	61.5338± .1250	8.1135± .0211	6.2581± .0183	77.0608± .1412	53.6486± .1063
Vaihiaiia south, 1923, pallida	67	15.2783± .0539	9.5388± .0318	62.2762± .1683	8.3179± .0278	6.4015± .0249	76.7686± .2085	54.3060± .1453
fusca (D)	85	15.1876± .0529	9.4459± .0287	62.1118± .1370	8.3329± .0297	6.3611± .0230	76.3706± .1582	54.7353± .1196
fulva	49	15.2092± .0475	9.0103± .0346	61.8062± .2006	8.3285± .0344	6.4224± .0263	77.0306± .1888	54.6428± .1697
zonata	20	15.3200± .0959	9.4500± .0485	61.7000± .2963	8.4100± .0560	6.5000± .0437	77.3000± .4063	54.8000± .2389
lyra	16	15.0875± .1129	9.2375± .0712	61.4375± .3495	8.2125± .0571	6.3125± .0453	77.0625± .3525	54.3125± .2746
All	237	15.2221± .0287	9.4595± .0170	62.0148± .0878	8.3261± .0163	6.3937± .0132	76.7447± .1016	54.5717± .0747
Matapoopoo middle, 1919, pallida	171	15.9289± .0394	9.2566± .0213	58.0965± .1094	8.6860± .0237	6.4427± .0170	74.1625± .1120	54.3948± .1083
fusca	125	15.8180± .0502	9.2264± .0243	58.2760± .1317	8.6920± .0273	6.4408± .0196	73.9800± .1535	54.7880± .1118
fulva	69	16.0195± .0556	9.2392± .0312	57.6739± .0914	8.7348± .0308	6.4913± .0220	74.3551± .2293	54.4710± .1437
phæa-purpurea	49	15.7296± .0678	9.1164± .0457	57.8266± .1901	8.6265± .0417	6.3531± .0327	73.4388± .3165	55.0102± .1785
frenata	5	15.8900± .1502	9.1800± .0615	57.3000± .4433	8.7800± .0818	6.4600± .0703	73.5000± .5047	55.1000± .5594
zonata	86	15.7616± .0617	9.1419± .0298	57.9419± .1575	8.6651± .0333	6.4093± .0234	73.8954± .2188	54.7558± .1400
lyra	47	15.7266± .0806	9.1085± .0349	57.8830± .2619	8.5341± .0428	6.3383± .0268	74.2447± .2327	54.0532± .2097
All	553	15.8540± .0226	9.2042± .0118	58.0118± .0626	8.6729± .0128	6.4266± .0091	74.0443± .0750	54.5814± .0566

TABLE 137—*Partula tæniata spadicea. Eastern series. Statistical description of the color classes*

Series	No.	Mean value							
		Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Maahumeru, 1919, pallida	7	15.8643±0.2487	9.3857±0.1581	59.3572±0.5189	8.2715±0.1425	6.4143±0.1055	78.5000±0.5507	51.7857±0.5237
fusca	20	15.9800± .0959	9.6300± .0507	60.1500± .3448	8.4000± .0518	6.5700± .0334	77.8500± .4430	52.5500± .2675
fulva	2	16.1000± .1669	9.6000± .0477	59.5000± .4769	8.6000± .1431	6.7000± .0954	78.5000± .0	53.0000± .2384
zonata[1]	1	16.55	10.10	61.50	8.90	6.90	77.50	53.50
frenata	2	15.2000± .0715	9.1000± .0954	60.0000± .2384	7.9000± .0	6.2000± .1431	80.0000±2.1462	51.5000± .4769
All	32	15.9313± .0838	9.5561± .0503	59.9063± .2455	8.3687± .0486	6.5312± .0356	78.1562± .3341	52.3750± .2060
Punahara, 1923, pallida	85	16.2606± .0585	9.6130± .0282	58.9824± .1916	8.7211± .0309	6.5964± .0234	75.5823± .1796	53.4617± .1385
fusca	197	16.3033± .0371	9.6695± .0194	59.2767± .1145	8.7081± .0187	6.5650± .0160	75.3173± .1191	53.3427± .0917
fulva	149	16.1655± .0433	9.6651± .0258	59.6274± .1238	8.6839± .0253	6.5993± .0197	75.8825± .1320	53.5604± .0975
frenata	11	16.2773± .1233	9.5909± .0856	59.1364± .4570	8.6818± .0636	6.5727± .0655	75.5000± .3679	53.2273± .3789
lyra	22	16.1273± .0939	9.5546± .0460	59.1818± .2755	8.5546± .0550	6.4727± .0360	75.8636± .2511	52.8637± .2861
All	464	16.2423± .0243	9.6505± .0132	59.3211± .0743	8.6948± .0131	6.5776± .0105	75.5776± .0756	53.4095± .0586
Marure, 1909, pallida	55	16.6100± .0928	10.0600± .0385	60.5000± .2248	8.8455± .0482	6.8527± .0431	77.4455± .2406	53.1182± .1764
fusca	116	16.5965± .0508	10.1345± .0278	61.0172± .1460	8.8638± .0288	6.9379± .0226	78.1552± .1677	53.3104± .1260
fulva	97	16.5222± .0172	10.0897± .0296	61.0154± .1613	8.8052± .0302	6.8670± .0236	77.9329± .1694	53.0980± .1107
zonata	3	16.6500± .2914	10.0333± .0367	60.5000± .9539	9.2333± .0367	7.0333± .0367	76.5000± .0	52.8333± .1836
lyra	16	16.9812± .0819	10.0000± .0653	58.7500± .2828	8.9250± .0816	6.8250± .0570	76.5000± .3626	52.3750± .3812
All	287	16.5930± .0330	10.0965± .0172	60.7857± .0955	8.8478± .0191	6.8924± .0140	77.8345± .1035	53.1446± .0745
Pupuhi-Teviroa, 1919, pallida	12	16.7500± .0804	9.9666± .0680	59.4167± .3353	8.8834± .0604	6.8000± .0584	76.3333± .3357	52.9166± .4598
fusca	24	16.8000± .0722	9.8584± .0595	59.3750± .3426	8.9166± .0496	6.8000± .0435	76.0833± .2808	53.7083± .3154
fulva	19	16.4553± .0977	9.7947± .0571	59.5000± .2131	8.8263± .0652	6.7632± .0522	76.6579± .2739	53.3421± .2851
phæa-purpurea	15	16.9300± .1316	9.9266± .0823	58.5000± .2463	9.0733± .0671	6.9000± .0983	75.9666± .2688	53.3666± .2533
zonata[1]	1	16.25	9.70	58.50	8.90	6.70	75.50	53.50
lyra	5	15.8900± .1055	9.4600± .0753	59.5000± .4266	8.6200± .0615	6.6200± .0482	78.5000± .8825	54.3000± .4826
All	76	16.5934± .0597	9.8448± .0321	59.2369± .1599	8.9000± .0295	6.7973± .0241	76.2763± .1488	53.9605± .1406
Pupuhi-Teviroa, 1923, pallida	24	15.9375± .0758	9.8084± .0502	61.3333± .2715	8.5916± .0605	6.6250± .0482	77.0417± .2724	53.6250± .2615
fusca	74	16.0513± .0576	9.8784± .0317	61.3648± .1755	8.6459± .0326	6.7216± .0268	77.7027± .2164	53.7027± .1563
fulva	88	16.1000± .0533	9.8409± .0303	61.0568± .1466	8.5773± .0291	6.6318± .0230	77.1364± .1463	53.1932± .1235
phæa-purpurea	41	16.1256± .0799	9.8610± .0403	61.1829± .2284	8.6756± .0427	6.7097± .0301	77.4025± .2347	53.7439± .1957
zonata[1]	1	15.05	9.30	62.50	8.30	6.50	77.50	55.50
lyra	13	16.4346± .0922	9.9769± .0597	60.8846± .4055	8.7154± .0577	6.7461± .0571	77.6538± .4163	53.0385± .2606
All	241	16.0869± .0314	9.8577± .0175	61.4971± .0924	8.6228± .0178	6.6675± .0142	77.3755± .1010	53.4876± .0810

[1] Class values.

TABLE 138—*Partula tæniata spadicea. Statistics of fecundity*

Series	Year	Records	Gravid	Per cent gravid	Eggs	Young	Total contents	Average for gravid	Average for all
Western:									
Uhene	1923	405	351	86.66	594	273	867	2.47	2.14
Vaihere	1909	66	50	74.63	75	52	127	2.54	1.89
Vaihere	1923	124	80	64.52	142	46	188	2.60	1.51
Vaihiaiia north	1924	141	102	72.34	142	87	229	2.24	1.62
Vaihiaiia middle	1909	168	112	66 66	137	98	235	2.10	1.40
Vaihiaiia south	1923	252	192	76.19	264	179	443	2.31	1.76
Matapoopoo	1919	234	176	75.21	238	140	378	2.15	1.61
Eastern:									
Maahumeru	1919	38	27	71.06	37	25	62	2.30	1.63
Punahara	1923	476	430	90.33	692	503	1,195	2.78	2.51
Marure	1909	327	252	77.06	404	198	602	2.39	1.84
Pupuhi-Teviroa	1919	81	61	75.31	68	72	140	2.29	1.73
Pupuhi-Teviroa	1923	265	212	80.00	383	166	549	2.59	2.07
Summary	....	2,577	2,045	79.36	3,176	1,839	5,015	2.45	1.94

TABLE 139—*Partula tæniata spadicea. Recorded adults and their embryonic contents*

Number of eggs	Number of young					Totals	
	0	1	2	3	4		
0	532	52	22	1	...	608	
1	310	367	181	13	...	871	
2	348	431	194	18	1	992	
3	36	48	18	1	1	104	3176 eggs.
4	.....	1	...	...	...	1	
5	1	...	...	...	...	1	
Totals	1,227	899	415	34	2	2,577	
		1,839 young					

Summary	Embryonic contents							
	0	1	2	3	4	5	6	7
Number of adults=2,577	532	362	737	650	255	38	2	1

TABLE 140—*Partula tæniata spadicea. Summary statistics of apparent heredity of coloration*

Class of parents	Number of young							Total
	pallida	fusca	fulva	phæa-purpurea	frenata	zonata	lyra	
pallida	139	247	19	...	...	...	...	405
fusca	89	464	73	...	...	...	...	626
fulva	45	303	121	...	...	...	...	469
phæa-purpurea	...	2	6	...	...	...	...	8
frenata	2	9	1	...	1	...	1	14
zonata	10	33	17	...	...	6	2	68
lyra	10	76	9	...	...	1	6	102
Total	295	1,134	246	...	1	7	9	1,692

TABLE 141—*Partula tæniata spadicea. Comparison of embryonic and adult color classes, in percentages*

	Color class						
	pallida	fusca	fulva	phæa-purpurea	frenata	zonata	lyra
Embryos	17.43	67.02	14.54	0	0.06	0.41	0.53
Adults	24.29	34.82	22.91	3.56	0.58	6.06	7.77

TABLE 142—*Partula tæniata propinqua. Statistical description*

Series	Year	No.	Shell			Aperture			Length aperture + length shell, proportions
			Length	Width	Proportions	Length	Width	Proportions	
Range (class values)									
			mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Tepatu	1919	57	15.95 −19.85	8.9 −10.7	49.5 −62.5	8.1 −10.1	6.1 −7.5	68.5 −81.5	47.5 −56.5
Tepatu	1923	132	15.65 −19.25	8.3 −10.9	52.5 −63.5	7.9 −10.3	5.5 −7.9	68.5 −80.5	47.5 −56.5
Matapoopoo	1909	13	15.95 −17.45	9.3 −10.5	55.5 −61.5	7.9 − 8.9	6.1 −7.1	72.5 −82.5	47.5 −55.5
Matapoopoo	1919	25	14.45 −17.75	9.1 −10.5	56.5 −64.5	7.9 − 9.7	6.1 −7.5	72.5 −80.5	49.5 −57.5
Vaihiaiia south	1923	3	16.25 −18.95	9.7 −10.7	56.5 −59.5	8.3 − 9.5	6.3 −7.3	75.5 −77.5	49.5 −51.5
Vaihiaiia middle	1909	43	14.75 −17.45	8.9 −10.3	53.5 −64.5	7.7 − 8.7	5.7 −6.9	70.5 −83.5	46.5 −54.5
Vaihiaiia north	1924	8	15.35 −17.45	9.3 −10.5	57.5 −61.5	7.9 − 8.7	6.3 −6.9	75.5 −83.5	48.5 −52.5
All		281	14.45 −19.85	8.3 −10.9	49.5 −64.5	7.7 −10.3	5.5 −7.9	68.5 −83.5	46.5 −58.5
Mean value									
Tepatu	1919	57	17.3711± 0.0693	9.8474± 0.0408	56.6403± 0.2279	9.1175± 0.0402	6.8649±0.0305	75.2369± 0.2541	52.2719± 0.1731
Tepatu	1923	132	17.2296± .0447	9.8485± .0250	57.0682± .1062	9.0773± .0269	6.8136± .0218	74.9242± .1392	52.5606± .1149
Matapoopoo	1909	13	16.7808± .1036	9.7923± .0641	58.3462± .2921	8.4077± .0541	6.5384± .0544	77.4231± .5108	50.7307± .3373
Matapoopoo	1919	25	16.3700± .1167	9.7880± .0576	59.7400± .3011	8.8120± .0625	6.8200± .0470	76.9000± .2616	53.7400± .2785
Vaihiaiia south	1923	3	17.2500± .4705	10.0333± .1836	58.5000± .5507	8.7000± .2203	6.7000± .1682	76.8333± .3671	50.5000± .3179
Vaihiaiia middle	1909	43	16.3128± .0571	9.6768± .0320	59.1977± .2015	8.2442± .0252	6.4582± .0243	78.1511± .2325	50.4303± .1543
Vaihiaiia north	1924	8	16.5875± .1694	9.8750± .0906	59.6250± .3252	8.3750± .0628	6.6500± .0619	79.5000± .5841	50.2500± .2859
All		281	17.0005± .0342	9.8167± .0168	57.6922± .0929	8.8794± .0215	6.7527± .0149	76.1264± .1116	52.1086± .0850
Standard deviation									
Tepatu	1919	57	0.7757± 0.0490	0.4566± 0.0288	2.5508± 0.1611	0.4500± 0.0284	0.3416±0.0215	2.8440± 0.1797	1.9377± 0.1224
Tepatu	1923	132	.7620± .0316	.4254± .0177	1.8099± .0751	.4577± .0190	.3711± .0154	2.3713± .0984	1.9569± .0812
Matapoopoo	1909	13	.5538± .0732	.3430± .0453	1.5614± .2065	.2895± .0382	.2910± .0384	2.7305± .3612	1.8030± .2385
Matapoopoo	1919	25	.8653± .0825	.4274± .0407	2.2321± .2129	.4633± .0442	.3487± .0332	1.9391± .1850	2.0645± .1969
Vaihiaiia south	1923	3	1.2083± .3327	.4714± .1298	1.4142± .3894	.4657± .1558	.4320± .1189	0.9428± .2596	0.8165± .2248
Vaihiaiia middle	1909	43	.5549± .0404	.3117± .0226	1.9593± .1425	.2452± .0178	.2385± .0172	2.2607± .1644	1.5003± .1091
Vaihiaiia north	1924	8	.7105± .1198	.3799± .0640	1.3636± .2299	.2634± .0444	.2598± .0437	2.4495± .4130	1.1990± .2021
All		281	.8493± .0242	.4188± .0119	2.3101± .0657	.5357± .0152	.3698± .0105	2.7736± .0789	2.1133± .0601

TABLE 143—*Partula tæniata propinqua. Statistics of tooth development*

Series	Year	No.	Index					Average
			1	2	3	4	5	
Tepatu	1919	65	63	2	..	..	..	1.0308
Tepatu	1923	203	189	14	..	..	..	1.0690
Matapoopoo	1909	16	11	5	..	..	..	1.3125
Matapoopoo	1919	28	23	5	..	..	..	1.0178
Vaihiaiia south	1923	3	2	1	..	..	..	1.3333
Vaihiaiia middle	1909	58	49	9	..	..	..	1.1552
Vaihiaiia north	1924	8	8	..	..	..	..	1.0000
All	.....	381	345	36	..	..	..	1.0945

TABLE 144—*Partula tæniata propinqua. Statistical description of the color classes*

Series	No.	Mean value						
		Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
Tepatu, 1919, pallida	11	17.7227±0.0800	9.6727±0.1136	54.5000±0.6253	9.2091±0.0657	6.7182±0.0440	72.9546±0.5009	51.3182±0.4187
fusca	19	17.5131± .0959	9.8474± .0584	56.1842± .3255	9.1316± .0561	6.8579± .0409	74.7632± .3208	52.0790± .2983
fulva	20	17.1950± .1489	9.9800± .0656	58.1000± .3283	9.1300± .0811	6.9800± .0583	76.5500± .4733	52.9500± .2800
zonata [1]	1	17.45	10.30	59.50	9.30	7.30	78.50	53.50
lyra	6	16.8500± .1508	9.6333± .0988	56.6666± .2471	9.8333± .1374	6.7000± .1101	76.0000± .2636	52.1666± .4680
All	57	17.3711± .0693	9.8474± .0408	56.6403± .2279	9.1175± .0402	6.8649± .0305	75.2369± .2541	52.2719± .1731
Tepatu, 1923, pallida	24	17.4750± .1155	10.0166± .0650	57.4166± .2023	9.1833± .0610	6.9333± .0619	75.2500± .3425	52.4166± .2780
fusca	56	17.0643± .0745	9.7786± .0422	57.1250± .1750	9.9822± .0467	6.7536± .0333	75.1250± .2224	52.4822± .1620
fulva	38	17.2053± .0681	9.8421± .0336	57.1053± .1871	9.0842± .0377	6.7895± .0339	74.6579± .2414	52.7105± .2261
zonata	5	17.3900± .1200	9.7000± .1079	55.7000± .6152	8.9400± .1038	6.6600± .0800	75.1000± .5265	51.5000± .7866
lyra	9	17.6166± .0905	9.9444± .0696	56.3889± .3425	9.4333± .0670	7.0111± .0640	73.8333± .4370	53.3888± .3157
All	132	17.2296± .0447	9.8485± .0250	57.0682± .1062	9.0773± .0269	6.8136± .0218	74.9242± .1392	52.5606± .1149
Matapoopoo, 1909, fulva	13	16.7808± .1036	9.7923± .0641	58.3462± .2921	8.4077± .0541	6.5384± .0344	77.4231± .5108	50.7307± .3373
Matapoopoo, 1919, pallida	6	17.0000± .0791	10.2666± .0588	59.8333± .5658	9.1333± .1471	7.2000± .0616	77.6666± .5829	54.3333± .6441
fusca	2	16.4000± .6438	9.8000± .1431	60.0000±1.6693	8.5000± .1908	6.8000± .1431	79.5000± .4769	55.5000± .9539
fulva	10	15.8900± .1828	9.5400± .0758	60.2000± .5315	8.6200± .0744	6.5800± .0638	76.1000± .2731	53.1000± .4392
lyra	7	16.5071± .1498	9.7286± .0880	58.9286± .2303	8.9000± .0904	6.8429± .0449	76.6429± .4804	53.6428± .3175
All	25	16.3700± .1167	9.7880± .0576	59.7400± .3011	8.8120± .0625	6.8200± .0470	76.9000± .2616	53.7400± .2785
Vaihiaiia south, 1923, fulva	3	17.1500± .4705	10.0333± .1836	58.5000± .5507	8.7000± .2203	6.7000± .1082	76.8333± .3671	50.5000± .3179
Vaihiaiia middle, 1909, fulva	40	16.2800± .0580	9.6750± .0214	59.2750± .2110	8.2300± .0263	6.4450± .0257	78.1500± .2426	50.4500± .1581
lyra	3	16.7500± .2774	9.7000± .0636	58.1666± .4857	8.4333± .0367	6.6333± .0367	78.1666± .8016	50.1666± .6619
All	43	16.3128± .0571	9.6768± .0320	59.1977± .2015	8.2442± .0252	6.4582± .0243	78.1511± .2325	50.4303± .1543
Vaihiaiia north, 1924, fulva	7	16.5500± .1943	9.8715± .1035	59.6428± .3713	8.3857± .0713	6.7000± .0609	80.0714± .5252	50.3572± .3175
lyra [1]	1	16.85	9.90	59.50	8.30	6.30	75.50	49.50
All	8	16.5875± .1694	9.8750± .0906	59.6250± .3252	8.3750± .0628	6.6500± .0619	79.5000± .5841	50.2500± .2859

[1] Class values.

TABLE 145—*Partula tæniata propinqua. Statistics of fecundity*

Series	Year	Records	Gravid	Per cent gravid	Eggs	Young	Total contents	Average for gravid	Average for all
Tepatu	1919	47	40	85.11	60	52	112	2.80	2.38
Tepatu	1923	191	148	77.49	270	113	383	2.59	2.00
Matapoopoo	1909	5	4	80.00	6	3	9	2.25	1.80
Matapoopoo	1919	11	11	100.	19	9	28	2.54	2.54
Vaihiaiia south	1923	3	2	66.66	4	2	6	3.00	2.00
Vaihiaiia middle	1909	58	35	60.34	45	31	76	2.17	1.31
Vaihiaiia north	1924	8	5	62.50	11	1	12	2.40	1.50
All		323	245	75.85	415	211	626	2.55	1.94

TABLE 146—*Partula tæniata propinqua. Recorded adults and their embryonic contents*

Number of eggs	Number of young						Totals
	0	1	2	3	4	5	
0	78	3	1	...	...	...	82
1	40	33	15	...	...	...	88
2	37	65	29	...	...	1	132 } 415
3	9	9	3	...	...	...	21 } eggs
Totals	164	110	48	...	...	1	323
			211 young				

Summary	Embryonic contents							
	0	1	2	3	4	5	6	7
Number of adults = 323	78	43	71	89	38	3	0	1

TABLE 147—*Partula tæniata propinqua. Summary statistics of apparent heredity of coloration*

Class of parents	Number of young					Total
	pallida	fusca	fulva	zonata	lyra	
pallida	10	24	12	..	..	46
fusca	3	24	36	..	..	63
fulva	..	25	30	..	..	55
zonata	..	2	3	..	..	5
lyra	..	9	2	1	2	14
Total	13	84	83	1	2	183

TABLE 148—*Partula tæniata propinqua. Comparison of embryonic and adult color classes, in percentages*

	Color-class				
	pallida	fusca	fulva	zonata	lyra
Embryos	7.10	45.90	45.35	0.59	1.09
Adults	15.75	27.30	45.93	2.36	8.66

TABLE 149—*Partula tæniata. Comprehensive statistical description*

Variety	Number	Shell			Aperture			Length aperture ÷ length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
Range (class values)								
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
elongata	5,223	12.65 —19.85	7.3 —10.9	46.5 —64.5	7.1 —10.9	4.9 —7.9	59.5 —79.5	45.5 —63.5
simulans	8,436	12.95 —19.85	7.3 —11.5	46.5 —67.5	7.1 —10.9	4.9 —7.9	61.5 —83.5	46.5 —62.5
striolata	5,977	12.35 —18.05	7.7 —10.7	51.5 —70.5	6.5 — 9.9	4.9 —7.5	66.5 —86.5	46.5 —60.5
nucleola	5,918	12.35 —20.15	7.5 —10.7	49.5 —68.5	6.7 —10.7	4.9 —7.9	65.5 —87.5	45.5 —60.5
spadicea	2,704	12.95 —19.55	7.7 —11.5	49.5 —70.5	7.3 —10.3	5.5 —7.9	65.5 —86.5	46.5 —61.5
propinqua	281	14.45 —19.85	8.3 —10.9	49.5 —64.5	7.7 —10.3	5.5 —7.9	68.5 —83.5	46.5 —58.5
Whole species	28,539	12.35 —20.15	7.3 —11.5	46.5 —70.5	6.5 —10.9	4.9 —7.9	59.5 —87.5	45.5 —63.5
Mean value								
elongata	5,223	16.1589± 0.0082	8.8462± 0.0046	54.6723± 0.0225	8.9207± 0.0047	6.2301±0.0038	69.6819± 0.0244	55.0979± 0.0188
simulans	8,436	16.2017± .0070	9.3094± .0045	57.4084± .0238	8.7090± .0040	6.4115± .0030	73.4950± .0209	53.6271± .0154
striolata	5,977	15.0858± .0065	9.2310± .0039	61.1471± .0216	8.0215± .0036	6.1664± .0030	76.7345± .0220	53.0648± .0160
nucleola	5,918	15.5166± .0083	9.1269± .0040	58.8043± .0222	8.3216± .0048	6.3876± .0036	76.7374± .0279	53.5149± .0162
spadicea	2,704	15.9094± .0112	9.6507± .0067	60.6146± .0375	8.6122± .0060	6.5987± .0048	76.5714± .0377	54.0211± .0257
propinqua	281	17.0005± .0342	9.8167± .0168	57.6922± .0929	8.8794± .0215	6.7527± .0149	76.1264± .1116	52.1086± .0850
Whole species	28,539	15.7979± .0040	9.2078± .0022	58.2869± .0142	8.5162± .0024	6.3430± .0017	74.4702± .0155	53.7755± .0084
Standard deviation								
elongata	5,223	0.8795± 0.0058	0.4957± 0.0032	2.4147± 0.0159	0.5070± 0.0033	0.4142±0.0027	2.6215± 0.0172	2.0156± 0.0133
simulans	8,436	.9478± .0049	.6121± .0032	3.2439± .0168	.5415± .0028	.4144± .0212	2.8435± .0148	2.0942± .0109
striolata	5,977	.7460± .0046	.4439± .0027	2.4814± .0183	.4157± .0025	.3458± .0021	2.5228± .0155	1.8320± .0113
nucleola	5,918	.9541± .0067	.4567± .0032	2.6861± .0157	.5449± .0039	.4168± .0029	3.1803± .0225	1.9599± .0114
spadicea	2,704	.8741± .0079	.5172± .0047	2.8897± .0265	.4629± .0042	.3795± .0035	2.9105± .0266	1.9907± .0182
propinqua	281	.8493± .0242	.4188± .0119	2.3101± .0657	.5357± .0152	.3698± .0105	2.7736± .0789	2.1133± .0601
Whole species	28,539	1.0015± .0028	.5639± .0015	3.5053± .0100	.5978± .0017	.4209± .0012	3.0762± .0110	2.1047± .0059

TABLE 150—*Partula tæniata. Summary statistics of tooth development. All shells*

Variety	Number	Index				Average
		1	2	3	4	
elongata, outer	2,318	2,317	1	..	..	1.0004
elongata, central	3,595	3,587	8	..	..	1.0022
elongata, Rotui sector	251	243	8	..	..	1.0318
elongata, all	6,164	6,147	17	..	..	1.0027
simulans, west outer	3,384	3,334	49	1	..	1.0151
simulans, west central	3,346	2,985	357	4	..	1.1091
simulans, east	2,687	2,362	322	1	2	1.1228
simulans, all	9,417	8,681	728	6	2	1.0792
striolata	6,584	3,745	2,821	18	..	1.4339
nucleola	6,778	5,897	873	7	1	1.1313
spadicea	3,116	2,517	599	..	..	1.1923
propinqua	381	345	36	..	..	1.0945
Whole species	32,440	27,332	5,074	31	3	1.1586

TABLE 151—*Partula tæniata. Comprehensive statistics of fecundity*

Series	Records	Gravid	Per cent gravid	Eggs	Young	Total contents	Average for gravid	Average for all
elongata	5,095	4,417	86.69	5,883	4,985	10,868	2.46	2.16
simulans	8,867	7,073	79.77	9,906	7,115	17,021	2.41	1.92
striolata	5,616	4,576	81.48	6,507	4,509	11,016	2.41	1.96
nucleola	5,762	4,315	74.89	6,271	3,673	9,944	2.30	1.73
spadicea	2,577	2,045	79.36	3,176	1,839	5,015	2.45	1.94
propinqua	323	245	75.85	415	211	626	2.55	1.94
All	28,240	22,671	80.28	32,158	22,332	54,490	2.44	1.93

TABLE 152—*Partula tæniata. Comprehensive statistics of apparent heredity of coloration*

Class of parents	Number of young							
	pallida	fusca	fulva	phæa-purpurea	frenata	zonata	lyra	Total
pallida	1,376	3,131	744	.....	2	5	1	5,259
fusca	759	4,818	1,687	.....	..	7	7	7,278
fulva	341	2,863	2,924	.....	1	5	1	6,135
phæa-purpurea	29	227	402	.....	..	..	..	658
frenata	137	519	220	.....	10	8	2	896
zonata	92	419	440	.....	1	13	2	967
lyra	45	349	153	.....	..	84	66	697
bisecta	.....	1	1	.....	..	..	..	2
Total	2,779	12,327	6,571	.....	14	122	79	21,892

TABLE 153—*Partula tæniata. Comprehensive comparison of embryonic and adult color classes in percentages*

	Color class							
	pallida	fusca	fulva	phæa-purpurea	frenata	zonata	lyra	bisecta
Embryos	12.694	56.308	30.015	.....	0.064	0.557	0.361	.....
Adults	23.385	33.773	27.614	3.569	4.214	3.708	3.733	0.003

TABLE 154—*Comprehensive statistical description of all species of Moorea*

Species	No.	Shell			Aperture			Length aperture + length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
Range (class values)								
		mm.	*mm.*	*p. ct.*	*mm.*	*mm.*	*p. ct.*	*p. ct.*
exigua, D	109	12.65 −17.45	7.5 − 9.7	51.5 −64.5	7.3 − 9.7	5.3 −6.9	66.5 −76.5	52.5 −59.5
tæniata, D	28,539	12.35 −20.15	7.3 −11.5	46.5 −70.5	6.5 −10.9	4.9 −7.9	59.5 −87.5	45.5 −63.5
solitaria, D	1	15.95	8.9	55.5	8.9	6.1	68.5	55.5
mirabilis, D	4,189	14.15 −19.85	8.1 −11.1	49.5 −65.5	7.3 −10.5	5.1 −7.3	60.5 −79.5	45.5 −59.5
mooreana, S	5,535	13.85 −20.75	7.9 −11.5	48.5 −66.5	6.9 −11.5	5.5 −8.1	64.5 −84.5	45.5 −61.5
aurantia, D	1,380	15.65 −21.05	8.5 −11.3	47.5 −61.5	7.7 −10.7	5.3 −7.7	62.5 −79.5	45.5 −58.5
olympia, S	34	17.75 −20.45	10.3 −12.1	53.5 −62.5	9.1 −10.9	6.7 −8.1	70.5 −80.5	49.5 −56.5
suturalis, D+S	12,567	15.05 −24.95	8.5 −12.9	46.5 −64.5	7.5 −12.3	5.7 −9.7	65.5 −88.5	43.5 −60.5
dendroica, S	101	18.95 −23.45	10.3 −12.5	46.5 −61.5	9.9 −11.7	7.1 −9.3	66.5 −81.5	46.5 −58.5
tohiveana, S	553	17.45 −24.35	10.1 −13.7	47.5 −62.5	8.9 −12.5	6.7 −9.3	65.5 −78.5	46.5 −58.5
Mean value								
exigua, D	109	15.2344± 0.0565	8.6413± 0.0255	56.7019± 0.1591	8.4835± 0.0309	5.9973±0.0208	70.6284± 0.1406	55.5642± 0.1095
tæniata, D	28,539	15.7979± .0040	9.2078± .0022	58.2869± .0142	8.5162± .0024	6.3430± .0017	74.4702± .0155	53.7755± .0084
solitaria, D[1]	1	15.95	8.90	55.50	8.90	6.10	68.50	55.50
mirabilis, D	4,189	16.6188± .0081	9.6249± .0042	57.8492± .0220	8.6668± .0042	6.0507± .0032	69.8208± .0262	52.0708± .0186
mooreana, S	5,535	17.3159± .0107	9.8897± .0049	57.1560± .0220	9.3378± .0056	6.8130± .0037	72.9262± .0225	53.8273± .0168
aurantia, D	1,380	18.4809± .0152	10.0062± .0076	54.0594± .0367	9.4011± .0066	6.7155± .0077	71.2268± .0478	50.7442± .0320
olympia, S	34	18.9500± .0762	11.0353± .0507	58.5294± .2389	10.0235± .0438	7.4588± .0335	74.4118± .2483	52.7647± .1970
suturalis, D+S	12,567	18.9607± .0080	10.5247± .0037	55.5067± .0140	9.6939± .0039	7.3531± .0039	75.8344± .0159	51.0715± .0118
dendroica, S	101	20.4856± .0576	11.2941± .0291	55.0941± .1730	10.7436± .0274	8.0921± .0243	75.2624± .1820	52.3416± .1377
tohiveana, S	553	21.7368± .0260	12.1611± .0142	55.9105± .0591	11.1072± .0137	7.9705± .0104	71.6230± .0711	51.0154± .0475
Standard deviation								
exigua, D	109	0.8752± 0.0399	0.3957± 0.0180	2.4621± 0.1125	0.4802± 0.0218	0.3224±0.0147	2.1762± 0.0994	1.6944± 0.0774
tæniata, D	28,539	1.0015± .0028	.5639± .0015	3.5653± .0100	.5978± .0017	.4209± .0012	3.8762± .0110	2.1047± .0059
solitaria, D	1							
mirabilis, D	4,189	.7762± .0057	.4068± .0029	2.1105± .0155	.4089± .0029	.3130± .0022	2.5148± .0185	1.7852± .0131
mooreana, S	5,535	1.1828± .0075	.5430± .0034	2.4321± .0155	.6222± .0039	.4107± .0026	2.4844± .0159	1.8505± .0119
aurantia, D	1,380	.8387± .0107	.4123± .0053	2.0248± .0259	.3670± .0046	.4229± .0054	2.6328± .0338	1.7655± .0226
olympia, S	34	.6589± .0531	.4385± .0358	2.0655± .1689	.3789± .0311	.2901± .0237	2.1468± .1756	1.7031± .1393
suturalis, D+S	12,567	1.3363± .0056	.6139± .0026	2.3243± .0099	.6534± .0027	.6512± .0027	2.6414± .0112	1.9664± .0083
dendroica, S	101	.8586± .0407	.4337± .0206	2.5782± .1133	.4084± .0194	.3625± .0172	2.7126± .1287	2.0524± .0974
tohiveana, S	553	.9089± .0184	.4947± .0100	2.0613± .0418	.4794± .0097	.3635± .0073	2.4787± .0503	1.6558± .0336
Co-efficient of variation								
exigua, D	109	5.7449± 0.2624	4.5791± 0.2092	4.3421± 0.1983	5.6604± 0.2586	5.3757±0.2455	3.0812± 0.1407	3.0494± 0.1393
tæniata, D	28,539	6.3394± .0179	6.1241± .0173	6.1168± .0173	7.0195± .0198	6.6357± .0187	5.2050± .0147	3.9138± .0110
solitaria, D	1							
mirabilis, D	4,189	4.6706± .0344	4.2265± .0311	3.6483± .0269	4.7180± .0347	5.1729± .0381	3.6018± .0265	3.4284± .0252
mooreana, S	5,535	6.8307± .0438	5.4905± .0352	4.2552± .0273	6.6632± .0427	6.0282± .0386	3.4061± .0218	3.4378± .0220
aurantia, D	1,380	4.5381± .0583	4.1204± .0529	3.7455± .0481	3.9038± .0501	6.2974± .0808	3.6963± .0474	3.4792± .0446
olympia, S	34	3.4770± .2844	3.9736± .3250	3.5290± .2886	3.7801± .3092	3.8893± .3181	2.8850± .2360	3.2276± .2640
suturalis, D+S	12,567	7.0477± .0300	5.8329± .0248	4.1874± .0178	6.7403± .0287	8.8561± .0377	3.4831± .0148	3.8503± .0164
dendroica, S	101	4.1912± .1989	3.8400± .1822	4.6796± .2221	3.8013± .1804	4.4797± .2126	3.6042± .1710	3.9212± .1861
tohiveana, S	553	4.1814± .0848	4.0679± .0825	3.6868± .0748	4.3161± .0875	4.5605± .0925	3.4608± .0702	3.2457± .0658

[1] Class values.

TABLE 155—*Comprehensive statistical description of the species of Moorea in terms of the class-values of the mean values referred to their averages*

Species	Shell			Aperture			Length aperture ÷ length shell, proportions
	Length	Width	Proportions	Length	Width	Proportions	
exigua, D	−8	−7	0	−5	−5	−1	+3
tæniata, D	−7	−4	+2	−5	−3	+3	+1
solitaria, D	−6	−6	−1	−3	−4	−3	+4
mirabilis, D	−4	−2	+1	−4	−4	−2	0
mooreana, S	−1	−1	+1	−1	0	−1	+1
aurantia, D	+2	0	−2	0	−1	0	−2
olympia, S	+4	+5	+2	+3	+3	+3	0
suturalis, D+S	+4	+2	−1	+1	+2	+4	−1
dendroica, S	+9	+6	−1	+6	+6	+4	0
tohiveana, S	+13	+10	−1	+8	+5	0	−1

TABLE 156—*Simplified coefficients of variation of the species of Moorea grouped according to the size of areas of occupation*

Area	Species	Shell			Aperture			Length aperture ÷length shell, proportions
		Length	Width	Proportions	Length	Width	Proportions	
Most contracted	*tohiveana*	4.18	4.06	3.68	4.31	4.56	3.46	3.24
	olympia	3.47	3.97	3.52	3.78	3.88	2.88	3.22
Wider	*exigua*	5.74	4.57	4.34	5.66	5.37	3.08	3.04
	aurantia	4.53	4.12	3.74	3.90	6.29	3.69	3.47
	dendroica	4.19	3.84	4.67	3.80	4.47	3.60	3.92
More extensive	*mirabilis*	4.67	4.22	3.64	4.71	5.17	3.60	3.42
	mooreana	6.83	5.49	4.25	6.66	6.02	3.40	3.43
Most extensive	*suturalis*	7.05	5.83	4.18	6.74	8.85	3.48	3.85
	tæniata	6.34	6.12	6.11	7.01	6.63	5.20	3.91

Plate 17

All shells natural size

Fig. 1—*Partula solitaria* new species. Taatuapæ division of Faatoai Valley.

Figs. 2–19—*Partula exigua* new species.

Figs. 2–9—**pallida**, from Paraoro middle; Maharepa (shortest, narrowest and slenderest aperture); Vaiare-Faamaariri, (shortest aperture); Paraoro (widest); Vaiare-Faamaariri (slenderest, 66 per cent); Vaiare-Faamaariri (stoutest aperture, 76 per cent); Paraoro middle, and Paraoro middle.

Figs. 10–13—**fulva**, from Paraoro middle (slenderest aperture, 66 per cent), Vaiare-Faamaariri, Vaiare-Faamaariri, and Paraoro south.

Figs. 14–19—**frenata**, from Paraoro middle, except figure 16, from Maharepa (longest).

Figs. 20–34—*Partula tohiveana* Crampton. All from Fareaito Valley.

Figs. 20, 21—**inornata simplex.** Figure 20, stoutest; figure 21, slenderest and nearly longest.

Figs. 22–24—**inornata apex.**

Figs. 25–27—**frenata simplex.**

Figs. 28, 29—**frenata apex.** Figure 29 is a dwarf mutant.

Fig. 30—**cestata.**

Fig. 31—Abnormal **frenata simplex.**

Fig. 32—Abnormal **inornata apex.**

Fig. 33—Adolescent **inornata.**

Fig. 34—Adolescent **frenata.**

Figs. 35–47—*Partula olympia* Crampton. All from Mouaputa Valley.

Figs. 35–37—**carnea.**

Figs. 38, 39—**castanea**, adult and adolescent.

Figs. 40, 41—**cestata vera.**

Figs. 42–44—**cestata helix**, the last an adolescent.

Figs. 45–47—**frenata**, the last an adolescent.

Figs. 48–51—*Partula dendroica* Crampton.

Figs. 48–50—**apex**, Pupuhi-Teviroa, the last an adolescent.

Fig. 51—**fusca**, Vaihiaiia Valley.

Partula solitaria new species, fig. 1; Partula exigua new species, figs. 2-19; Partula tohivcana Crampton, figs. 20-34; Partula olympia Crampton, figs. 35-47; Partula dendroica Crampton, figs. 48-51.

Plate 18

All shells natural size

Figs. 1–18—*Partula dendroica* Crampton.

Figs. 1, 2—**fusca**, Vaihiaiia, the latter an adolescent.

Fig. 3—**castanea**, Vaihiaiia north.

Figs. 4–10—**cingulata**, the last an adolescent; all from Pupuhi-Teviroa, except figure 7, from Vaihiaiia.

Figs. 11, 12—**cestata**, Matapoopoo.

Figs. 13, 14—**zonata**, Tepatu.

Figs. 15–18—**quadriga**, from Tepatu, except figure 15 from Matapoopoo.

Figs. 19–48—*Partula aurantia* new species.

Figs. 19–28—**fusca**, all from Paraoro Valley, except figure 26 from Vaiare-Faamaariri. Figures 23, 24, abnormalities; figures 27, 28, adolescents.

Figs. 29–35—**lyra**, figures 29, 30, 35 from Paraoro; figures 31–34 from Paparoa.

Figs 36–39—**asymmetrica**, from Paparoa, Vaiare-Vaipohe, Vaiare-Vaipohe and Vaiare-Faamaariri.

Figs. 40–43—**zonata**, all from Paraoro.

Figs. 44–46—**phæa**, all from Paraoro.

Fig. 47—sinistral **lyra** from Paparoa.

Fig. 48—sinistral **lyra** from Paraoro.

Figs. 49–53—*Partula mirabilis* Crampton.

Figs. 49–52—**apex**. Figure 49, from Faataofe; figures 50–52 from Maramu.

Fig. 53—**apex strigata**, from Matapoopoo.

Partula fondeana Crampton, figs. 1-18; Partula aurantia new species, figs. 19-48; Partula mirabilis Crampton, figs. 49-55.

Plate 19

All shells natural size

Figs. 1–37—*Partula mirabilis* Crampton.

Figs. 1, 2—**apex strigata**, respectively from Matapoopoo west and Matapoopoo east.

Fig. 3—sinistral **apex**, from Maramu Valley.

Figs. 4–8—**mitella**. Figures 4–6 from Faataofe; figure 7, Maramu; figure 8, Fareaito Valley.

Figs. 9–15—**phæa**. Figures 9–11 from Mouaroa; figure 12, Maramu (lighter spire); figure 13, adolescent, from Maramu; figures 14, 15, sinistral individuals, from Faataofe Valley.

Figs. 16–25—**lyra**. Figures 16–19 from Matapoopoo; figures 20, 21, Faataofe; figures 22, 23, Matapoopoo; figure 24, Faataofe; fig. 25, sinistral mutant, from Faataofe Valley.

Figs. 26–30—**zonata**. Figures 26–28 from Maramu; figure 29, Tefeo (split zone); figure 30, adolescent, from Faataofe Valley.

Figs. 31–33—**subzonata**, all from Tefeo Valley.

Figs. 34–37—**bisecta**, all from Faataofe Valley.

Figs. 38–64—*Partula mooreana* Hartman.

Figs. 38–42—**pallida**, from Maramu, Vaianai, Haapiti (toothed margin), Vaianai (dwarf) and Atimaha Valley.

Figs. 43–49—**fusca**, from Vaianai, Haapiti (exceptionally broad) Vaianai, Oio (giant), Atimaha, Atimaha, and Maramu (unusual shape).

Figs. 50–53—**fulva**, from Vaianai, Vaianai, Vaianai, and Atimaha.

Figs. 54–58—**phæa**. Figures 54–56 from Maramu; figures 57, 58, Atimaha.

Figs. 59–64—**frenata**. Figures 59–62 from Vaianai; figure 63, Maramu; figure 64 Fareaito (exceptionally slender).

Partula mirabilis Crampton, figs. 1-37. Partula mooreana Hartman, figs. 38-64

Plate 20

All shells natural size

Figs. 1–16—*Partula mooreana* Hartman.

Figs. 1, 2—**frenata**, both from Atimaha Valley.

Figs. 3–6—**cingulata**. Figure 3 from Vaianai, others from Atimaha.

Figs. 7–10—**bisecta**, all from Vaianai.

Figs 11, 12—**zonata**, both from Maramu.

Figs. 13–16—dextral mutants. Figures 13–15, **fusca**, from Maramu, Maramu, and Faataofe; figure 16, **frenata**, from Faataofe.

Figs. 17–51—*Partula suturalis vexillum* Pease.

Figs. 17–21—**apex**, from Haapiti, Haapiti, Tefeo, Vaiare-Faamaariri and Vaiare-Faamaariri.

Figs. 22–31—**strigata**, from Haapiti, Haapiti, Maraarii, Maraarii, Vaianai, Maramu, Faataofe, Vaiare-Faamaariri, Maraarii (tinged lip) and Oio (giant).

Figs. 32–35—**frenata**, extreme types, respectively from Urufara south (longest, 24.85 mm.), Tefeo (slenderest aperture, 65 per cent), Morioahu east (stoutest aperture, 88 per cent), Vaiare-Faamaariri (highest proportion of aperture length to shell length, 60 per cent).

Figs. 36–43—**frenata**, types and variants, from Maramu, Vaianai, Maramu, Vaianai, Vaianai, Faataofe, Paahonu and Oio.

Figs. 44–47—**frenata**, abnormal shells, the first from Vaiare-Puutu, others from Vairahi.

Figs. 48, 49—**frenata**, variant **basalis**.

Fig. 50—**frenata**, with basal and sutural markings, from Vaiare-Faamaariri.

Fig. 51—**unilineata**, from Vaiare-Faamaariri.

Partula mooreana Hartman, figs. 1-16; Partula suturalis vexillum Pease, figs. 17-51

Plate 21

All shells natural size

Figs. 1–30—*Partula suturalis vexillum* Pease.

Figs. 1, 2—**unilineata**, adult and adolescent, from Vaiare-Faamaariri.

Figs. 3–7—**cestata**, from Moruu, Varari, Varari, Varari and Maraarii.

Figs. 8–14—**zonata**, diverse variants, from Mouaputa, Mouaputa, Mouaputa, Maraarii, and Oponohu west; figures 13, 14 abnormal shells.

Figs. 15, 16—**subzonata**, both from Atimaha Valley.

Figs. 17–24—**bisecta**, diverse variants, from Moriahu east, Morioahu east, Varari, Faataofe, Faataofe, Vaiare-Puutu (**lata**), Fareaito (lowest proportion of aperture length to shell length, 43 per cent), Vaiana (stoutest, 64 per cent).

Figs. 25–30—**atra**, from Varari, Varari, Mouaputa, Maraarii, Faataofe and Morioahu east.

Figs. 31-51—*Partula suturalis strigosa* Pfeiffer.

Figs. 31, 32—**pallida**, both from Haumi Valley.

Figs. 33–40—**strigata**, from Hotutea (shortest), Paia, Hotutea, Hotutea, Maatea, Maatea, Haumi and Haumi.

Figs. 41–47—**frenata vera**. Figures 41–44 from Hotutea; figure 45, Maatea, fig. 46, Haumi; fig. 47, Hotutea (dwarf).

Figs. 48–50—**frenata alternata**, from Atiraa, Hotutea and Hotutea.

Fig. 51—**cingulata vera**, from Hotutea.

Partula suturalis vexillum Pease, figs. 1-30; Partula suturalis strigosa Pfeiffer, figs. 31-51

Plate 22

All shells natural size

Figs. 1–28—*Partula suturalis strigosa* Pfeiffer.

Figs. 1–5—cingulata vera, all from Haumi, except figure 2, from Hotutea.

Figs. 6–8—cingulata alternata, from Atiraa, Haumi and Haumi.

Figs. 9, 10—cingulata vera-zonata alternata, both from Maatea.

Figs. 11–14—zonata vera, all from Maatea.

Figs. 15, 16—zonata alternata, both from Maatea.

Figs. 17–21—bisecta vera. Figures 17–19, from Haumi; figures 20, 21, from Hotutea.

Figs. 22, 23—bisecta alternata, from Haumi and Hotutea.

Figs. 24, 25—bisecta lata, both from Hotutea.

Figs. 26–28—phæa, from Haumi, Hotutea and Hotutea.

Figs. 29–62—*Partula tæniata elongata* Pease.

Figs. 29–33—pallida, from Haapiti, Haapiti, Matapoopoo west, Vaianai and Vaianai.

Figs. 34–40—fusca, from Oio (longest), Vaianai, Vaianai, Atimaha (pinkish variant) Vaianai (streaked), Haumi (streaked) and Vaianai (adolescent).

Figs. 41–43—fulva, from Oio, Oio and Atimaha.

Figs. 44–46—phæa purpurea, from Fareaito, Tefeo east and Tefeo east.

Figs. 47–53—frenata, from Oio, Oio, Vaianai, Vaianai, Oio, Irua (mutant) Mouaputa.

Figs. 54–58—zonata, from Oio, Paahonu, Fareaito, Fareaito and Fareaito.

Figs. 59, 60—lyra, both from Mouaputa.

Fig. 61—bisecta, unique shell, from Fareaito.

Fig. 62—sinistral mutant, fulva, from Oio.

Figs. 63, 64—*Partula tæniata simulans* Pease.

Figs. 63, 64—pallida, both from Pafatu.

Partula taeniata steenosa Pfeffer, figs. 1–28; Partula taeniata elongata Pease, figs. 29–32; Partula taeniata simulans Pease, figs. 33–64.

Plate 23

All shells natural size

Figs. 1–38—*Partula tæniata simulans* Pease.

Figs. 1–4—pallida, from Morioahu, Paparoa, Taapurau and Taapurau; the last a sinistral mutant.

Figs. 5–11—fusca, from Tiaorooro, Paparoa, Vaipua, Maatepua, Varari (stoutest, 67 per cent), Morioahu east (slenderest 46 per cent) and Morioahu (rosy variant).

Figs. 12–18—fulva, from Morioahu east (one of longest), Vairahi (lowest proportion of aperture length to shell length, 46 per cent), Vaipua, Vaipua, Morioahu, Morioahu (reddish variant) and Taapurau.

Figs. 19–24—phæa-purpurea, from Pafatu (stoutest aperture, 83 per cent), Varari (one of broadest, 67 per cent), Vaiana, Taapurau, Taapurau (sinistral mutant) and Taapurau (adolescent).

Figs. 25–30—frenata, from Pafatu, Pafatu, Hotutea (highest proportion of aperture length to shell length, 62 per cent), Vairahi (shortest—12.95 mm.), Taapurau and Taapurau (deep bands).

Figs. 31–35—zonata, from Atiraa (transitional) Mouaroa, Tiaorooro, Vaiare-Vaipohe (variant) and Atiraa (variant).

Figs. 36–38—lyra, all from Paparoa. Figure 38 a variant.

Figs. 39–64—*Partula tæniata striolata* Pease.

Figs. 39–41—pallida, from Paraoro, Paraoro and Tepu.

Figs. 42–46—fusca, all from Maharepa, except figure 46 from Farehotu; figure 44, shortest, 12.35 mm.; figure 45, stoutest, 70 per cent; figure 46, stoutest aperture, 86 per cent.

Figs. 47–51—fulva, from Paraoro (one of longest and a giant in its valley), Maharepa, Tepu, Tepu and Maharepa (adolescent).

Figs. 52–54—phæa-purpurea, from Oroau (shortest aperture, 6.5 mm.), Vaiare-Faamaariri and Paraoro.

Figs. 55, 56—frenata, from Vaiare-Faamaariri and Vaiare-Vaipohe.

Figs. 57–61—lyra, from Maharepa, Maharepa, Maharepa (variant), Paraoro south (unique), Farehotu (dark variant).

Figs. 62–64—zonata, from Vaiare-Faamaariri, Vaiare-Faamaariri and Vaiare-Vaipohe.

Partula taeniata simularis Pease, figs. 1–38; Partula taeniata striolata Pease, figs. 39–64.

Plate 24

All shells natural size

Figs. 1–25—*Partula tæniata nucleola* 'Pease' Garrett.

Figs. 1–4—pallida, Faatoai-Vaipapa (shortest, 12.25 mm.), Faatoai (stoutest aperture, 87 per cent), Faatoai and Poararua.

Figs. 5–8—fusca, Faatoai-Taatuapae (broadest, 68 per cent) Urufara south (slenderest, 49 per cent), Poararua (giant, 20.15 mm.) and Faatoai-Terahimaue.

Figs. 9–13—fulva, Aareo (slender aperture, 65 per cent), Faatoai-Taatuapæ (lowest proportion of aperture length to shell length 45 per cent), Urufara south, Urufara south (reddish variant) and Poararua.

Figs. 14, 15—phæa-purpurea, Urufara south and Faatoai-Vaipapa.

Figs. 16–18—frenata, all from Urufara.

Figs. 19–21—zonata, from Faatoai-Mataitau, Urufara south and Urufara south.

Figs. 22–25—lyra, from Aareo, Faatoai-Mataitau, Faatoai-Vaipapa, Faatoai-Mave (deep colors).

Figs. 26–47—*Partula tæniata spadicea* Reeve.

Figs. 26, 27—pallida, both from Uhene.

Figs. 28–30—fusca, from Punahara (uniform), Marure (streaked, stoutest aperture, 86 per cent), and Maahumeru (streaked).

Figs. 31–35—fulva, Uhene (shortest, 13.0 mm.), Punahara (longest, 19.4 mm.), Punahara (reddish-brown variant), Uhene and Punahara (dark extreme).

Figs. 36, 37—phæa-purpurea, Pupuhi-Teviroa and Matapoopoo.

Figs. 38, 39—frenata, Punahara, and Matapoopoo.

Figs. 40–42—zonata, Uhene, Uhene and Matapoopoo (deep colors).

Figs. 43–46—lyra, Punahara, Punahara, Matapoopoo (variant), and Pupuhi-Teviroa (mutant).

Fig. 47—fulva, sinistral mutant from Vaihiaiia.

Figs. 48–64—*Partula tæniata propinqua* new variety.

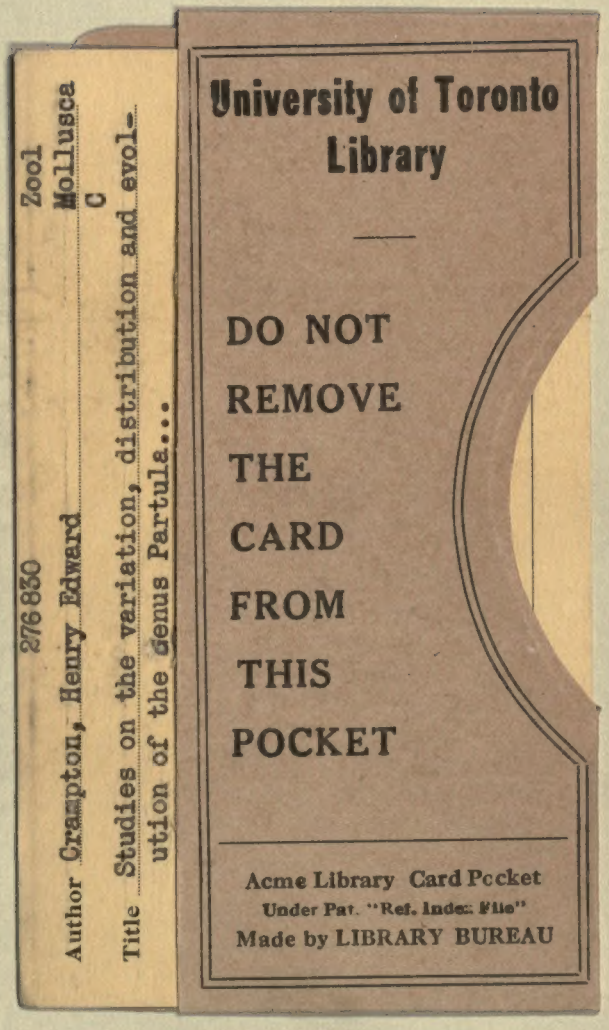
Figs. 48, 49—pallida, Matapoopoo and Tepatu.

Figs. 50, 51—fusca, both from Tepatu.

Figs. 52–56—fulva, figures 52, 53 from Vaihiaiia north, figures 54–56 from Tepatu.

Figs. 57–60—zonata, all from Tepatu, figures 59, 60, variants.

Figs. 61–64—lyra, from Tepatu, Tepatu, Vaihiaiia (vague bands) and Tepatu (vague bands).

Partula taeniata mucicola Pease, Garrett, figs. 1-25; Partula taeniata spadicea Reeve, figs. 26-47; Partula taeniata propinqua new variety, figs. 48-64.

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